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INSIDE:

AN ENGINEER'S GUIDE TO CONTROLLER CONSIDERATIONS

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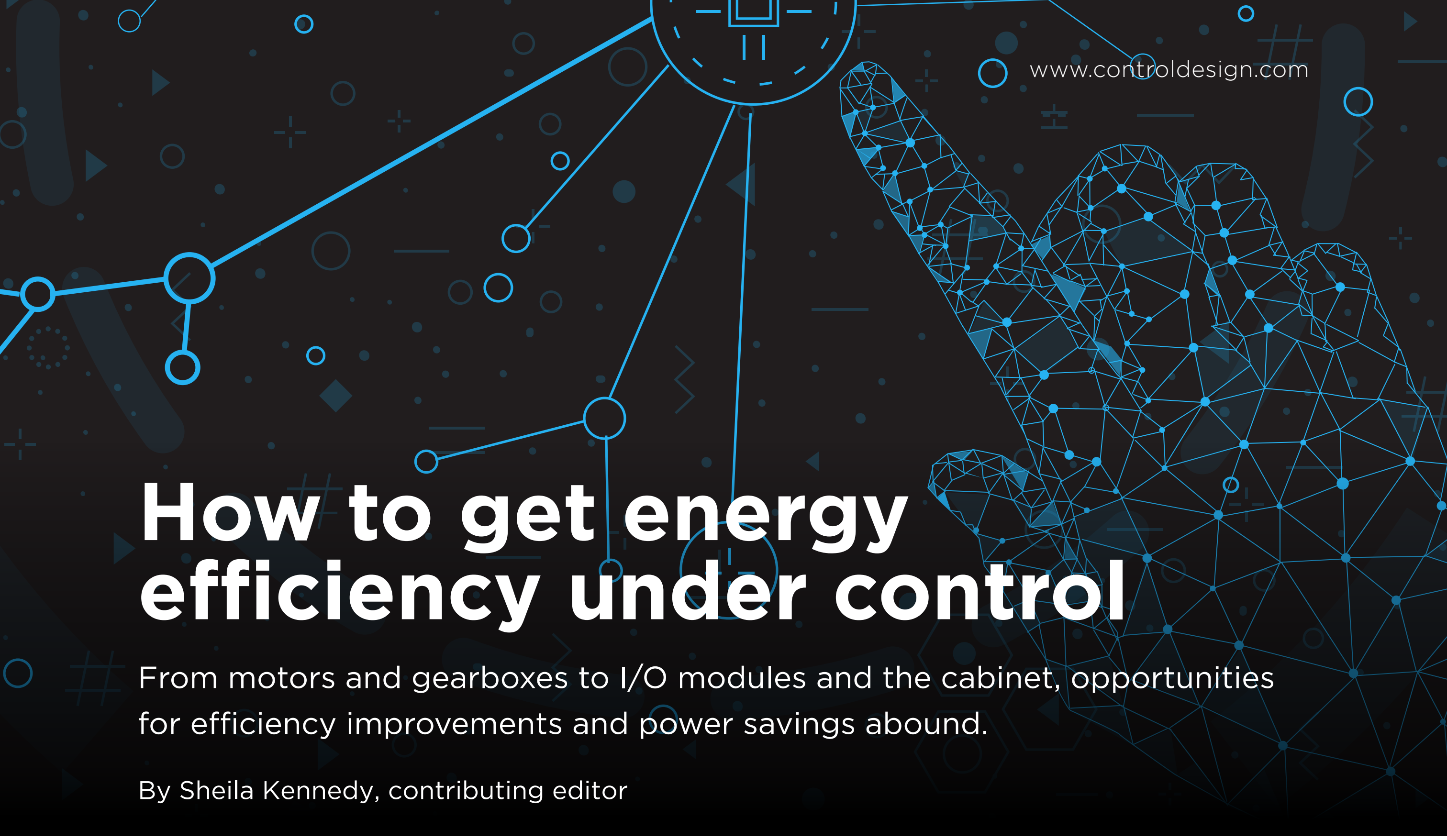


How to get energy efficiency under control

From motors and gearboxes to I/O modules and the cabinet, opportunities for efficiency improvements and power savings abound.

By Sheila Kennedy, contributing editor

Because of their increased intelligence capabilities, controllers offer the greatest opportunities to make closed-loop adjustments that translate into more efficient processes, suggests Danny Weiss, senior product manager at Newark element14. "Energy management functions can be embedded in controllers for managing various operating modes and diagnostics," he says. "Because PLCs and PACs have increased their capabilities to handle more input and output, there's less need for individual I/O modules. With the cloud and the Internet, you're able to get remote access to smaller, more efficient and faster-running equipment. Even the controllers themselves are a lot smaller."

The control cabinet can be structured accordingly to improve thermal management and efficiency. "Smaller, more efficient components mean less heat dissipation, which allows for smaller fans," says Weiss. "Using fewer components reduces the wiring, thus reducing the heat. Because the signal is now digital, as opposed to analog, it is more efficient so less energy is required to send the signal." Reducing heat also helps to preserve electronic equipment and reduce breakdowns.

"We see the increased use of intelligent pressure control, such as reducing the pressure on a no-load return stroke for a cylinder, which is easily accomplished by adding a pressure regulator but greatly increases efficiency," says John Bridges, technical business manager at Aventics. "Increasingly, pressure regulators are being integrated into custom valve manifolds that we build (Figure 1)."

The Internet of Things includes things, such as machines, says Mary Burgoon, market development manager at Rockwell Automation. "How do the machines in a plant talk to each other to modulate production when there is a blockage or a machine goes down?" she asks. "Do they automatically send a machine-to-machine (M2M) signal to shut it down and slow down production until that machine can come back online? The next target is dependency and smart connections from machine to machine."

Everything electrical is sized based on the amount of current that goes through it, so if you can reduce your energy consumption on each individual machine by 5% or 10%, it allows your energy infrastructure to handle more with a smaller system, explains Rich Mintz, product manager for gear motors at Siemens. "You see that all the way down to the drive train," he says. "For example, a two-stage bevel gearbox and a worm gearbox are about the same size and have almost the same form fit function from the outside, but because of the inefficiency inside of the mechanical system, you're going to lose one-half to one-third of the energy that you put into the worm gearbox. That means buying more motor, a larger drive and a larger circuit breaker than you would need with the two-stage bevel gearbox. That adds up pretty fast."

UNDER PRESSURE
Figure 1: Pneumatic cylinders are used in pick-and-place applications for filling trays with food items.

PREDICTIONS

"With the new Small Motor Rule in March 2015 and the Integral Horsepower Rule in June of 2016, adoption of premium-efficient motors could exceed 90% of the motors sold for use in the United States," says John Malinowski, senior manager of industry affairs at Baldor Electric. "The U.S. Department of Energy (DOE) is working on regulations to control system efficiency for pumps, fans and compressors that are expected to take effect in 2019-2020. Plus, the Extended Motor Product Label Initiative (EMPLI) incentives could cause development of systems that will be above the DOE regulations, causing further energy savings."

Higher-efficiency permanent-magnet motors will be deployed and require drives with new control algorithms, explains David Schrader, product manager at Fuji Electric Corp. of America. "Some of our drives already incorporate algorithms that allow for control of PM motors," he says (Figure 2).

"At a minimum, I believe end users of machines are going to require machine builders to provide energy usage information to plant-wide energy monitoring systems," says Corey Morton, director of technology solutions at B&R Industrial Automation. "Machine builders will need to adopt industry standards such as OPC UA to provide the needed connectivity in a uniform way (Figure 3)."

Where machines start to play a role in lean Six Sigma principles is connected smartness, variable manufacturing and work in progress (WIP), says Phil Kaufman, energy technology manager at Rockwell Automation. "I can see a day where machines will start to turn on and turn off and use WIP in between them," he predicts. "For instance, machines A and C will run and build WIP, and, when they go into a low power state and B comes up, it will consume the WIP and create new WIP

Source: Fuji Electric

CABINET ALGORITHMS

Figure 2: Higher-efficiency permanent-magnet motors will be deployed and require drives with new control algorithms incorporated into drives.

Source: B&R Automation

WYSIWYG

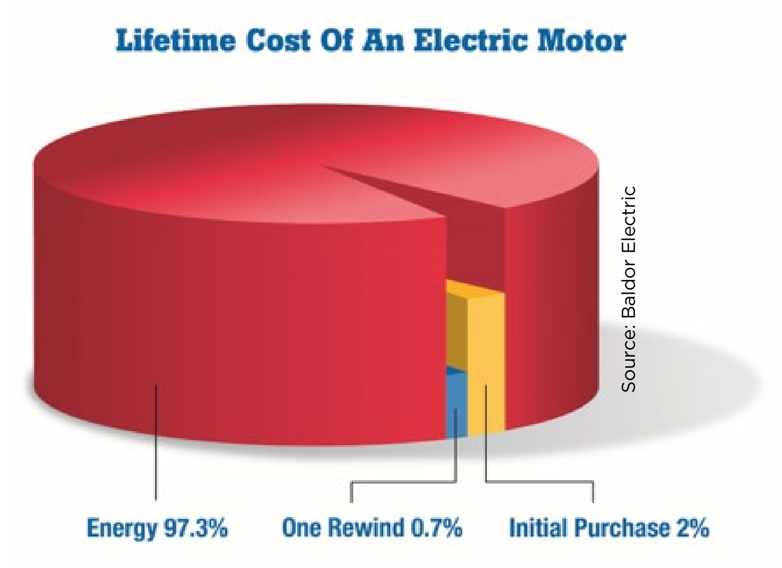
Figure 3: Users of machines are going to require machine builders to provide energy usage information to plant-wide energy monitoring systems.

before going back to sleep. This provides the opportunity to save energy, even while manufacturing at a lower throughput."

Kaufman sees the connectivity moving into how energy is optimized economically. "Say I have a contractual requirement to reduce my load in the next hour. Can I do demand management by reducing my load on the shop floor and still meet my manufacturing needs?" he asks.

"With all machines speaking the same language and looking at the production schedule, it becomes predictive and self-modulating," adds Rockwell Automation's Burgoon. "It's really future-state but probably not that far off, given where communication protocols and the technology and sensors are going."

The purchasing paradigm must also change. "Purchasing folks must get onboard with strategies to save energy and purchase equipment that is more productive," suggests Malinowski. "Many of them are schooled to save on first cost, which is mostly in conflict with energy efficiency or even productivity. A motor's first cost is just 2% of the life cost, whereas over 97% is for energy used for its operation (Figure 4)."



CIRCLE OF LIFE
Figure 4: A motor's first cost is just 2% of the the life cost, whereas 97% is for energy used during its operation.

Energy-smart machine designers will be able to offer their customers the opportunity to include energy as a line item in the bill of materials of the product being produced, suggests Arun Sinha, engineer at Opto 22.

"In the end-user world, one of the things we see down the road is that facilities will start to track energy down to the machine level the same way they track scrap, cycle time and things like that," predicts Siemens' Mintz. "Every decision is different from plant to plant and process to process. It's important to understand the options so that you as an engineer can take that information and design your machines to save energy, and make yourself or your customer more competitive."

To PLC or not PLC? That is the question

The programmable logic controller fights back and continues to go the distance

By Rick Rice, contributing editor

The general trend over the past 5-10 years points at an emerging preference of programming languages over traditional ladder logic for machine control. While there have always been those who spout the benefits of structured text (ST) over ladder logic (LAD), the waters are further muddied by what I would call a merging of PC-based programming with automation programming.

As the availability of trained, PLC-based technicians and engineers dwindles, the void is being filled, although at a slow rate, by graduates of software-applications programs at the university level.

The change in direction, it seems, has long been anticipated by automation manufacturers as the development of the standard IEC 61131-3 is all about opening up the platform to use alternates to the LAD approach to writing a control algorithm.

As a “classic” programmer, I have long suspected structured-text-based algorithms of being overcomplicated gobbledygook designed to push us vintage code developers out of the mainstream. While I studied the early structured languages in college, I have always felt that LAD was easier to troubleshoot for those who didn’t have specific programming training. “I haven’t run across much in the packaging-machinery business that demands more than LAD can provide.”

I do, however, acknowledge that structured languages are far more powerful as a programming tool when the need arises. My firm grip on LAD as a programming base is founded on my observation that I haven't run across much in the packaging-machinery business that demands more than LAD can provide.

A search of online sources will indicate that the most popular programming platforms these days are Java, C, C++, Python and C#, with VB, SQL and Assembly much further down the list in a category of less than 2% usage compared to the top five on the list.

Automation vendors must clearly see that to keep their share of the market, automation controllers must have the ability to incorporate these programming standards into the platform or risk losing ground to the PC-based controllers.

Call me an old guy, but after all these years of having them around, I still haven't looked at a PC-based control platform as anything other than an attempt by a home-computer provider trying to tap into the automation market. There are some fine manufacturers of industrial PCs, but something just doesn't feel right to me about deploying these in the field when they find their origins on a desktop device.

A look into the evolution of packaging machinery shows some interesting trends. Early packaging equipment was relay-based technology. Timing was maintained using mechanical cams, much like machines have used since the dawn of the industrial revolution. During the late 1960s and through the 1980s, machinery providers embraced the advent of the computer chip to reduce the use of relays and wiring by basing their designs on these early processor chips and developing printed circuit boards to interface with the real devices on a machine.

Once down that path, machinery providers had no choice but to follow the initial investment in this technology by continuously improving their use of the technology to the point where the control system was a complicated system that only electronics experts could support.

For the end user, these systems were beyond the skill level of most maintenance providers. Product support involved calling the manufacturer to discuss the problem and, in many cases, purchasing replacement components to be plugged into the black box of a control system.

With the development of the PC in the early 1980s came the co-development of the PLC. Computer-based controls, with a relatively easy programming language, LAD, stuffed into an industrial package that could be mounted in a control box on a machine, provided a means of reducing some of the complication of the control system and a means by which the end user could step up the ability to troubleshoot issues and arrive at solutions without great involvement or cost from the original vendor.

While PLCs became the mainstream control method for machinery, processor-based controls for essential devices such as checkweighers and metal detectors kept these devices in the black-box realm until recently.

With the ever-evolving technology in the PLC-based world, some manufacturers who have successfully deployed PLCs in past have taken on the chip-based applications with new PLC technology. The results are a win for the end user as the solution removes the mystery of the black box.

I had the opportunity just recently to experience such an innovation when a well-known OEM in the auger and volumetric filler business came out with a PLC-based checkweigher. Now those who have been in the business for a while might immediately blurt out that this can't be done. Fast response times and accuracy of samples are the realm of PC-based quality control.

Well, this oldtimer was very surprised to learn that not only was the PLC-based platform fast, it was degrees more accurate than our other weight-measuring equipment. We observed decimal accuracy on very light pouches in a particular application that was astonishing.

So, here's where this starts to get interesting. As a contract packager, we have a large inventory of checkweighing equipment, some of them at least 20 years old. While we have good intentions, the fact is we aren't as quick to replace this older equipment due to simple economics—remembering the old adage, "If it ain't broke, don't fix it."

This policy works for a time, but suddenly we find ourselves having more and more difficulty making repairs to this equipment. These are all circuit-board level, microprocessor-based devices, and, while the cream of the crop when we first purchased them, time has passed them by.

The general tendency of folks in the checkweighing and other key product-monitoring business entities is to follow the PC-based technology. Let's think about that for a moment.

PCs have been around for about 40 years. Much has changed from those early days. The processors get smaller and faster. The capabilities get greater. Operating systems seem to have a 3-year lifespan, and that usually means having to change or upgrade the hardware platform soon after, as the hardware folks are busy supporting the new operating system and don't want to spend much time and resources on supporting what is now a legacy item.

Unlike a PC investment at $800-$1,500 or so, a checkweigher or other such device costs tens of thousands of dollars. If the hardware or operating system is going to improve every 3-5 years, how does the end user keep up with that advancement? Well, the truth is they don't. They end up spending money on replacement boards and third-party repairs to keep that investment going.

With a PLC-based device, the expectation is that the platform is going to be around more than a few years. Sure, there will be firmware updates, but the structure of the base platform will remain the same.

Look at the legacy of the Allen-Bradley PLC-5 or SLC 500 from Rockwell Automation; the Siemens Simatic S5 and S7 series; or Schneider Electric's Modicon 84 series. The original company name, Modicon, was derived from modular digital control, and that is the emphasis here—everything is modular. The processors improved over the years but the ability to plug new technology into the same platform is a key attraction to a PLC-based system.

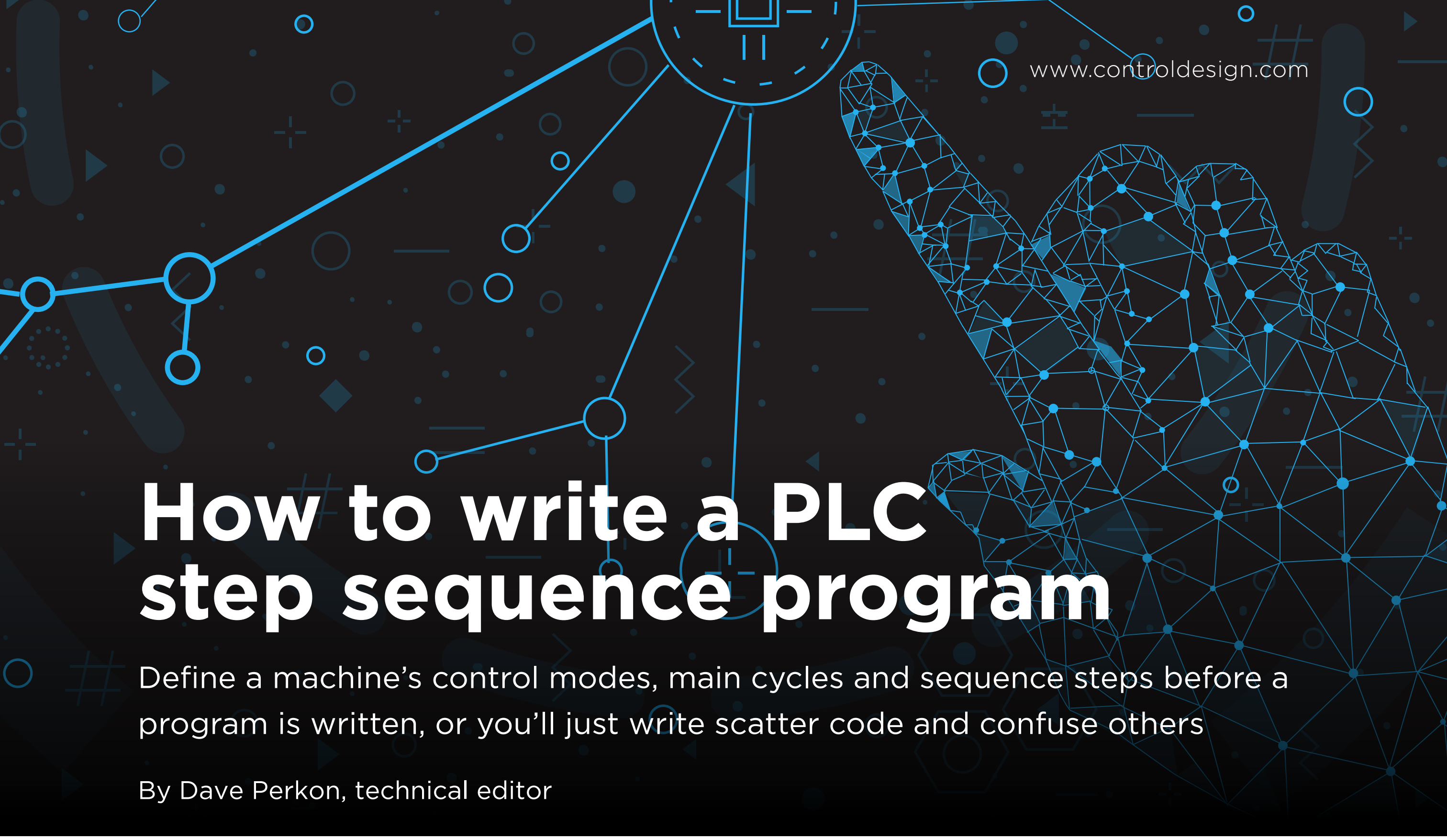
Now I'm not saying there isn't a place for PC-based control. In my experience, critical control systems for energy production, nuclear power plants, the aerospace industry and other similar pursuits will always have a need for the PC-based systems. These types of systems require constant improvement, and the dependency on an anchored base platform would prohibit such endeavors.

However, for general manufacturing such as food, beverage, automotive and other consumer goods, a base platform that can be easily added to or upgraded makes a lot of sense.

The PLC is quite capable of fighting back and holding its own. Automation companies that have been lured into the PC-based market by the abundance of graduate programmers from the IT world are starting to find ways to slide back into the comfortable clothes that is the PLC platform.

Our experience with the PLC-based checkweigher has inspired us to look at a wholesale replacement of our legacy equipment on a much more aggressive timeline than has been our policy to date. We have long lamented the short lifespan of our quality-assurance investments, and the emergence of a product based around a platform that is intended to last for a decade or more is extremely attractive to us.

It will be interesting to see where this trend leads. The labor crisis we now face hits all aspects of the business. Production workers and skilled laborers are in high demand, and even the machinery makers are feeling the pinch. If they can use their current skilled staff, familiar in a PLC-based control system, and develop products that are outside of their traditional product lines, the opportunities for continued growth will provide jobs and revenue for years to come.



How to write a PLC step sequence program

Define a machine's control modes, main cycles and sequence steps before a program is written, or you'll just write scatter code and confuse others

By Dave Perkon, technical editor

Many programmers in the automation industry struggle with what is the best way to write a PLC program for machine automation. There are also many programmers who know the best way or right tool to use and proceed to use many of the IEC 61131 programs on a single machine. Whether it's the inexperienced or the experienced writing the PLC program, simple ladder logic and a step sequence is often the best solution.

No doubt there are arguments for using a variety of programming methods to control a machine, but breaking down a machine cycle into modular pieces of code and defining the automatic sequence steps before writing a single line of code is a great starting point. Then, using ladder diagram programming, and maybe few function blocks or add-on instructions, the program can be quickly written, and it will be easy to support for the long term.

It is necessary to define the machine's mode control and functions to start, stop, pause or exit a machine cycle. Write it down. Then break down the step sequence into manageable size cycles, often two or more per machine or station, and type up a software functional document detailing what triggers a cycle, what its home position is and each cycle's step sequence.

In its basic form, a machine automation sequence typically has two to four control modes. Typical control modes include automatic, step, manual and no mode. While starting, run-

> "The completed step sequence ladder diagram coils must be readable as the sequence of operation, in order, from top to bottom of the program logic."

ning, waiting, faulted and stopping may be machine states, they're not modes and are a subject outside the scope of this column.

Automatic mode continuously cycles the machine during production. Step mode runs each step or several steps of a sequence each time a step button is pressed and is useful during machine setup and troubleshooting. Manual mode allows actuators to be moved through use of HMI buttons or operator pushbuttons.

Modes enable program logic such as ok to start a cycle, automatic sequence in cycle and step sequence cycle, pause cycle and cycle stop functions. Where the work happens is in the automatic step sequence.

For example, a pick and place (P&P) machine may have two automatic cycles, a pick sequence and a place sequence. Each cycle begins with steps to home the machine or station automation and then typically waits at mid-sequence step until a machine condition or tooling position is met or based on part presence or absence. While there may be many other requirements to continue a sequence to the next step, logically, a part present at pickup bit and no part in gripper bit will start the pick sequence. Logically, for the place cycle to start, a part present in gripper bit and no part at the place position bit will start the sequence.

For this discussion, the motions used in this pick and place machine include a gripper raise and lower cylinder, a gripper extend and retract cylinder and a gripper open and close actuator, all with the related end of travel sensors.

With no part in the gripper, the home position for the P&P is with the gripper raised, retracted and open. However, the home position may vary. With a part in the gripper, the home position is with the gripper raised, extended and closed. The sequence simply moves the tooling to the correct position at the start of a cycle, enabling the tooling to be in any position when the cycle begins.

When triggered, the pick sequence homes the P&P moving it above the pickup position using the following sequence steps: raise gripper, move to pickup, open gripper. When at the home position, the next step waits for a part present at pickup. With a part present, the step sequence continues with lower gripper, close gripper, set part present memory, raise gripper and move to above the place position where the pick cycle complete bit is set ending the pick sequence, resetting all step output coils and the sequence repeats. A fault followed by a reset button press can complete a cycle, as well.

The place step sequence operates in a similar fashion but is only started when a part is present in the gripper, and the pick sequence is not in cycle. In any step sequence, it is important to include steps at the beginning and perhaps the end of the cycle to home the machine and tooling before work is performed, and part tracking bits are set and reset.

Feel free to add steps to the end of a pick sequence that are the same as at the start of a place sequence; the program will only need one scan to solve the logic, but it will confirm a home position and may speed up the machine by getting the tooling closer to the work step.

The completed step sequence ladder diagram coils must be readable as the sequence of operation, in order, from top to bottom of the program logic. Don't create scatter code. Feel free to add steps such as check part tracking for good part, wait for dial to index and save part status. Make the logic clearly shows current work being done and then tie it to outputs logically as Step A and not Step B.

There is much more to writing a proper machine PLC program, but a well-written and documented step sequence can tolerate poorly defined memory usage and other program issues. Its simplicity helps encourage adding extra sequence steps to highlight the work being done at any point in the cycle.

4 machine control trends

Flattening networks, combining PCs and PLC and self-learning machines are just some of the machine control trends we can expect now and in the near future

By Dave Perkon, technical editor

I always enjoy talking to the many vendors and manufacturers available to control system designers, engineers and programmers. There are so many to choose from. Some represent products from many manufacturers, and others manufacture a wide variety of products. They seem to understand how to help to create a great machine control system, and they have the products to make it happen.

The foundational pillars of a great machine control system are product reliability, performance consistency and ease of integration and support, says Mike Chen, director of the Automation Center at Omron Automation Americas. "These allow manufacturers to guarantee high quality production at an optimum cost," he explains. "Any hardware, software or services offered need to take these factors into account. The direction that machine control innovation is heading ultimately boils down to these three factors."

The automation and machine control industry is currently flourishing with new innovations and strategies, and it can be difficult to determine what the future will hold, adds Sriram Ramadurai, marketing manager, controllers/components/safety, at Omron Automation Americas. "Machine control in particular is at the heart of numerous new automation strategies because it connects individual machines to the business logistics systems and integrates robotics, vision and other technologies into a comprehensive automation solution," he says. "It also has a significant impact on the security of the overall system."

Newark is the one-stop source for all the components you need to build a machine control system from sensor information gathering to cloud communications and back, says Danny Weiss, senior product manager at Newark element14. "Because machine control plays such an important role in industrial automation, it's essential to understand the factors that are driving the evolution of today's control technology forward," he says. He and his partners at Omron provide some specific trends in industrial automation.

Trend 1—More integration between the control- and enterprise-level networks: "Today, all talk of machine control and automation must include Industrial Internet of Things (IIoT) connectivity," says Weiss. "Traditionally, automation systems have been built according to a pyramid-shaped visualization known as the Purdue Model. This model provides a means for organizing key manufacturing operations into a hierarchy, with the lowest level being the actual physical processes themselves and the highest level being the overarching business logistics systems. In between these two are the intelligent devices, control systems and manufacturing operations systems, with each layer consolidating data from the one below it and feeding the data into the layer above."

This hierarchical model may not be long for this world—that is, the currently blossoming world of the IIoT. "The automation industry is seeing a trend of increased hardware integration between network levels that the Purdue Model designates as separate," says Weiss. "Increased peer-to-peer networking and a flatter approach to manufacturing operations offer the advantage of utilizing fewer hardware pieces but also generate new concerns about security and reliability. It can be hazardous to blindly expose critical process controls to the Internet, so manufacturers seeking to take advantage of more hardware integration are also taking measures to increase security."

Trend 2—Leveraging the benefits of both PCs and PLCs: "Historically, there has been a bit of a back-and-forth regarding the use of PCs versus PLCs," says Weiss. "PLCs are more reliable and more optimized for machine control, but PCs offer greater flexibility and greater processing power. The near future may see a tendency to try to include more complex software functionality, such as algorithms for data analysis, onto PLCs. An example of this idea in action today would be an IPC that has a split-core PLC and PC. This provides all the reliability one expects from an IEC 61131 programmable controller, but it runs in parallel with PC software inside the same piece of hardware and stays immune to Windows OS crashes.

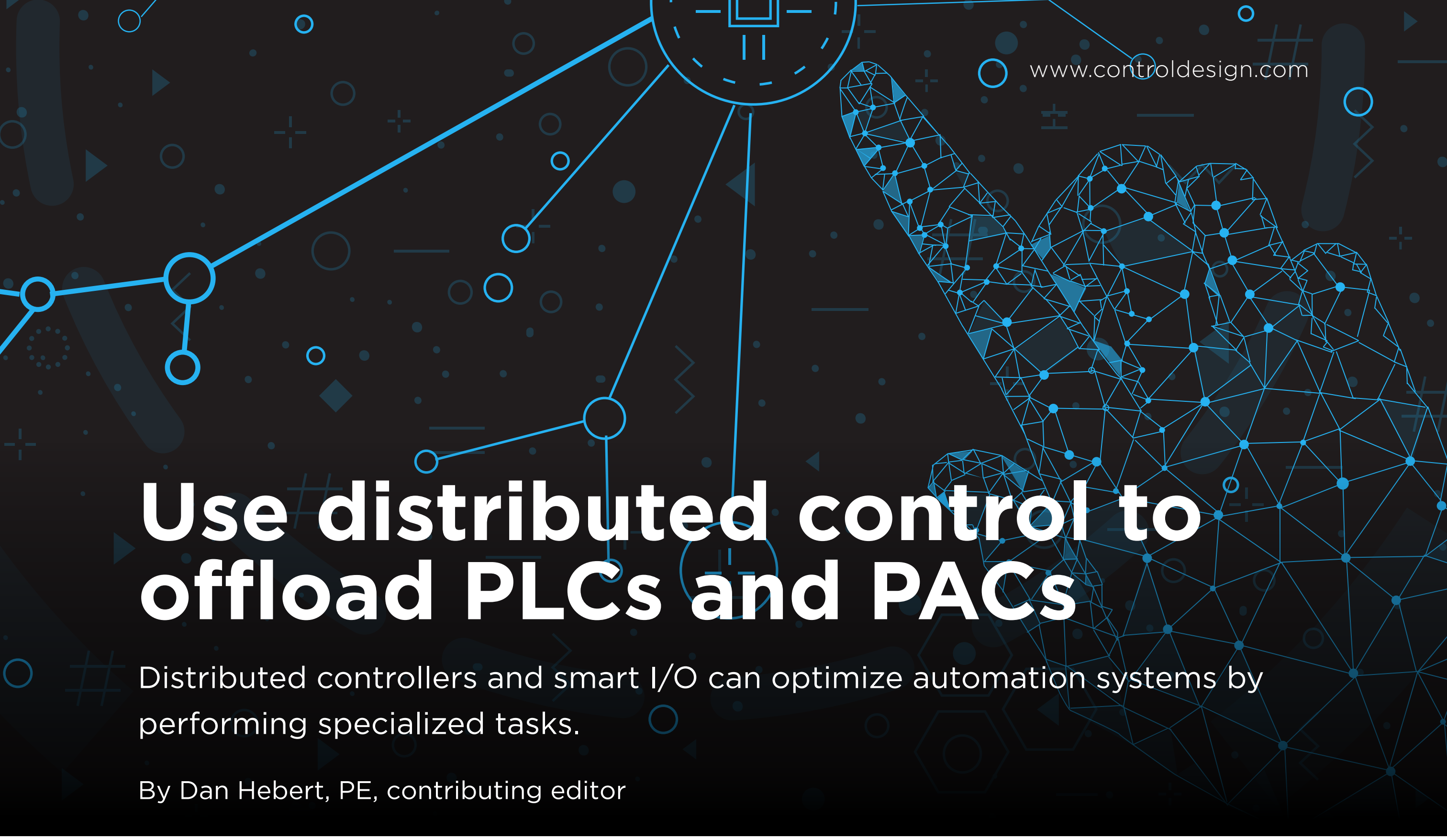
Trend 3—Getting the machines to learn on their own: "Machine learning algorithms are increasingly being leveraged to detect patterns and anomalies in machine function," says Ramadurai. "In some cases, these machine-learning engines run within the machines themselves. It's a trend that in turn is fueling interest in the two trends discussed above. Anomaly detection—the practice of analyzing machine data to recognize outliers relative to normal operation—is an area in which machine learning can be extremely helpful. Whereas traditional periodic maintenance struggles to find the economic optimum between excess service cost versus risk of downtime cost, new predictive maintenance methods can request maintenance tasks in response to trends observed in machine data in real time."

The use of machine learning to improve maintenance and keep an eye on machine functionality poses significant benefits for manufacturing facilities that could suffer excessive amounts of machine downtime when experienced workers leave, continues Ramadurai. "Applying machine learning to maintenance can minimize downtime while new hires are learning the ropes," he says.

Trend 4—Integrated solutions with a single integrated development environment (IDE): "As automation solutions become more capable and more complex, manufacturers are beginning to see great value in implementing integrated solutions from a single supplier," says Weiss. "This strategy dramatically reduces the engineering costs of automation design and integration, and it also makes maintenance much less complicated. In addition, the use of a single IDE for programming all aspects of automation—including sensing, motion, vision, robotics and safety—can cut down on the time required to train operators because they only need to familiarize themselves with a single software interface."

Although there's a lot happening in the automation industry right now, these four trends seem likely to define machine control for the near future, continues Weiss. "Manufacturers are striving to incorporate more automation into their lines to boost quality and productivity, and this is driving the need for more creative machine control strategies," he says.

In addition, automation is beginning to spread its wings outside the traditional environment of manufacturing and make an impact in various commercial sectors, although at a more tentative pace. "It all comes back to what value you can bring to the customer, and if the juice is worth the squeeze," says Chen. "It's an exciting time for this industry, and many new trends, strategies and innovations are likely to pop up in coming years."



Use distributed control to offload PLCs and PACs

Distributed controllers and smart I/O can optimize automation systems by performing specialized tasks.

By Dan Hebert, PE, contributing editor

When automation professionals hear the phrase "distributed control system" or its acronym DCS, they usually think about the huge, monolithic and expensive control systems often used in big process plants. Ironically, most distributed control systems in process plants don't distribute control at all, but instead consolidate it into a few centralized processors.

But, when it comes to machine automation, distributed control means something else entirely. In this case, distributed control means taking a real-time control or data processing task away from the main controller and distributing it to one or more cabinet- or field-mounted controllers. The main reasons for using distributed control are to perform specialized tasks, add redundancy, improve performance and simplify programming.

CONSIDER DISTRIBUTED CONTROL

Figure: Machines such as this metal press often require extensive control of hydraulic motion, a task better performed by a distributed controller than by the main PLC or PAC. (Source: Delta Computer Systems)

Distributed controllers can be used to perform tasks not easily handled by the main controller, particularly if the main controller is a PLC, as opposed to a more powerful PAC. Safety-rated distributed controllers are perhaps the most widespread use of distributed controllers.

Instead of upgrading the main controller to a very expensive safety-rated PLC or PAC to handle hundreds of standard and a few safety I/O points, it's often much more cost-effective to simply add a safety-rated controller to handle the safety I/O. The distributed safety-rated controller can be a simple smart relay if there are just a few points of safety I/O or a small safety-rated PLC to handle more I/O. In either case, savings can be significant as compared to using a safety-rated main controller with its hundreds of I/O points.

Another specialized task often handled by distributed controllers is motion control. Although many PLCs and PACs can in theory be programmed to control motion, it's often more cost-effective to use one or more motion controllers to perform this custom control activity, instead of trying to make the main controller do something a bit outside its main realm of capability.

"The main reasons for using distributed control are to perform specialized tasks, add redundancy, improve performance and simplify programming."

Hydraulic motion control is a good example of a task that could in theory be handled by a main controller but is often instead best addressed with a specialized distributed controller. "Our motion controllers are capable of optimizing machine functionality via precise closed-loop control of hydraulic and electric servo position, velocity, pressure/force or torque, enabling the main controller to concentrate on other functions," says Bill Savela, director of marketing at Delta Computer Systems.

"If the main controller, such as a PLC, were to perform the motion control function in addition to other functions, the system would likely not be able to achieve as high a degree of motion precision and/or axis synchronization. This is in part because a main controller must divide its time among many diverse tasks and may not be able to close the control loop associated with any one specific control function fast enough," adds Savela.

"Our controllers can also perform custom processing of sensor feedback. If multiple sensors are highly sensitive to different ranges of inputs, switching among them can extend the range of feedback sensitivity incorporated into the control loop. Mathematical operations can also be performed on sensor data before it is incorporated into the control loop. This enables the motion controller to perform precise control even when the sensor responds to field conditions in a nonlinear manner. These capabilities expand on the power of the distributed controller, enabling greater precision and/or reliability, and offloading the main controller," concludes Savela.

Another specialized task is data acquisition and processing for sensors and other input points not needed for real-time control. Although it's possible to wire all of these points back to the main controller, it's often not cost-effective, particularly for retrofits where new sensors are being added. Although this is not strictly distributed control as real-time control is not being performed, it is an important part of the automation system, and some control functions are usually required to manage and massage the sensor data.

(Source: Delta Computer Systems)

CONSIDER DISTRIBUTED CONTROL

Figure: Machines such as this metal press often require extensive control of hydraulic motion, a task better performed by a distributed controller than by the main PLC or PAC.

"One major influence of the Industrial Internet of Things (IIoT) is the rapid addition of sensors to various machines," says Mark Lochhaas, product sales manager at Advantech. "Many end users are recognizing the need to sense virtually every operating parameter and bring corresponding data to the cloud, but this requires a component between the sensor and the cloud. There are various layers of data collection, concentration, pre-storage analysis and communication; and distributed control in the form of intelligent remote I/O can be used to encompass these layers by performing the data-acquisition corresponding tasks."

In the future, sensors will be used more widely and become more intelligent, probably moving from hardwired connections and industrial protocols to more IT-friendly protocols such as message queuing telemetry transport (MQTT), a publish/subscribe, extremely simple and lightweight messaging protocol designed for constrained devices and low-bandwidth, high-latency or unreliable networks. "Remote I/O and other edge computing platforms will become smaller and more powerful with enhanced communication capability yet consume less power. Software development will allow collaboration among devices and platforms for significantly more sophisticated distributed control. Centralized control will always be necessary, but it will become more supervisory," believes Lochhaas.

"One of the benefits of using a distributed controller in place of a standard I/O device is that the distributed controller can back up the main controller if it goes down, and take over and safely shut down the process," says Noah Glenn, product manager for fieldbus technology at Turck (www.turck.us). Another benefit is offloading the main controller from tasks that can consume a significant amount of processing power. And, because control is local, it can often be much faster than with simple remote I/O, which must communicate back and forth with the main controller.

"Distributed controllers can be used to enable localized, flexible distributed machine control in applications such as conveying and other material handling systems," adds Glenn. "Other possible control applications are those in which things have to happen in a certain order such as those utilizing RFID, grippers, die protection, recipes, motor speed, counting, light curtains and other components and functions."

Distributed controllers can be programmed in a variety of ways. Some are programmed with PC-based software using ladder logic and other IEC-61131 languages such as flow charts or scripting.

Whether they are called distributed controllers, smart remote I/O or specialized controllers, these components can be used to design better automation systems. Trends such as the IIoT often require the addition of sensors, and it's often more cost-effective to handle these added input points with distributed control. Increased emphasis on safety along with new regulations often require the addition of safety-rated I/O, another task often best handled by distributed control.