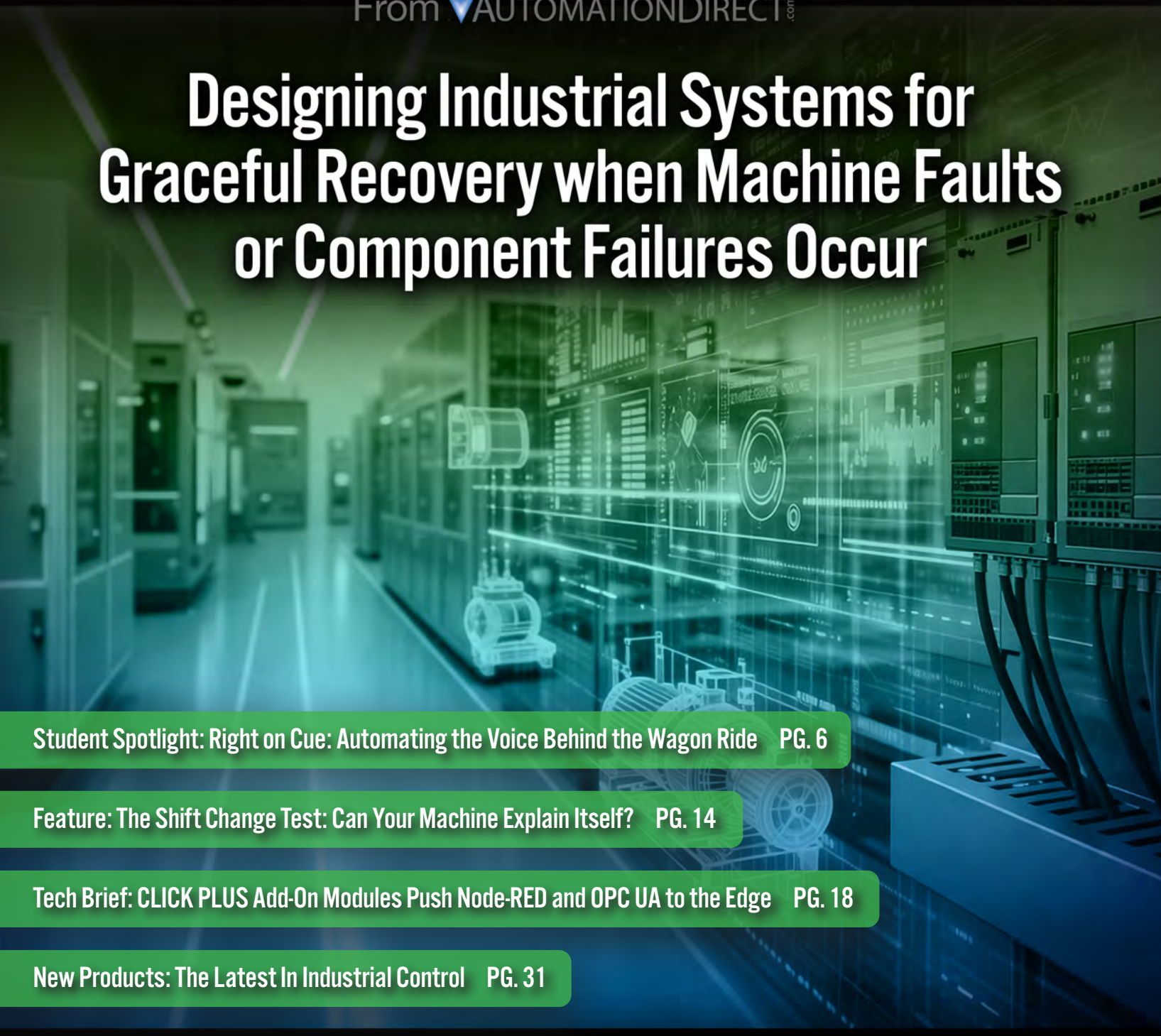
Automation NOTEBOOK

Your guide to practical products, technologies and applications

From AUTOMATIONDIRECT.com

Designing Industrial Systems for Graceful Recovery when Machine Faults or Component Failures Occur



Student Spotlight: Right on Cue: Automating the Voice Behind the Wagon Ride PG. 6

Feature: The Shift Change Test: Can Your Machine Explain Itself? PG. 14

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November 2026

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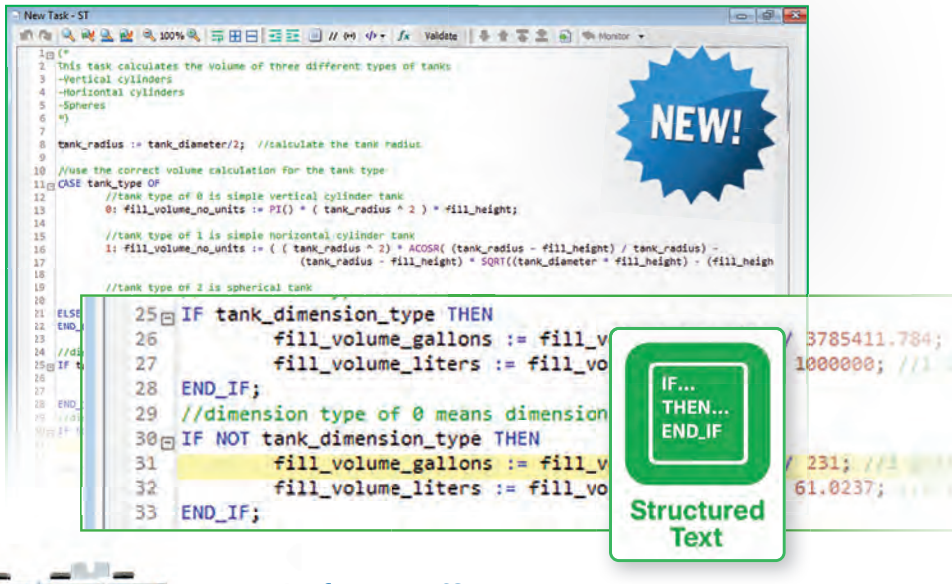
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The Age of the Intuitive Machine



Stephanie Neil
VP, Editorial Director
sneil@arrowfly.com

When an operator has been working on a line for years, they get to know the machines and the subtle signs that something is wrong. A keen sense can detect a vibration or a hum that may be the initial indication that a failure is imminent.

But that kind of tribal knowledge isn't transferable. A new group of operators won't have the instinct to be proactive and will likely have to figure out what's going on after a failure occurs.

Wouldn't it be nice if the machine could just tell us what's happening? Well, with the right technology, it can.

In this issue, AutomationDirect's Bill Dehner explains how digitalization and data-driven insights are laying the groundwork for self-explaining machines. An array of smart devices working together can capture and present detailed condition and operating data that is displayed on an HMI.

This "machine intuition" takes the burden off the operator to figure out what's wrong — because the machine tells them exactly what's going on. That means, however, that equipment must be designed the right way in the beginning.

Inevitably, there will be a failure, so even if an operator has enough information to understand where the problem is, there should still be a predetermined recovery process. We explore what that looks like in our second feature story on how to design industrial systems for a graceful recovery after a fault or a failure.

AutomationDirect's Alex Maercz walks us through the planning that must take place before a machine ever hits the factory floor. To that end, it's the responsibility of the design team to program for an event, building in what should happen when something does not work as intended. Turn to page 10 to learn more, including the design mistakes that can turn a minor failure into extended downtime.

There's so much more to explore in this issue. From upgrading a crankshaft forging line with a full control system to modernizing the electrical and controls of a potato processing plant. And, since it's November, how about a hayride in a trailer outfitted with a hearty PLC that powers the ride audio system to improve the guest experience and allow the driver to focus on the safety of the passengers. Turn to page 6 to read "Right on Cue: Automating the Voice Behind the Wagon Ride."

And, of course, there's always the popular Brainteaser to keep you on your toes. Enjoy!



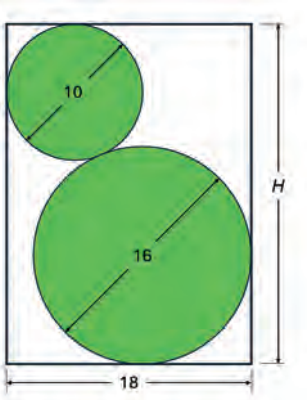


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BRAIN TEASERS

Circular Vernacular

Given that the two tangent circles are inscribed in the rectangle as shown, find the height of the rectangle.





Sticky Fishy

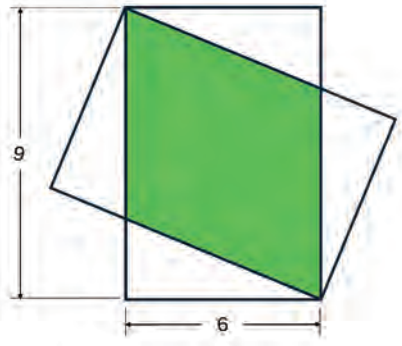
These eight LED enclosure lights have been arranged in the shape of a fish. Can you move only three of the lights to flip the shape of the fish, so that it "swims" to the right?

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Rectangle Mangle

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AutomationDirect Productivity1000 Named Honoree in Endeavor 2026 EDGE Awards

New standalone "mini" form factor PLCs with built-in I/O expand the Productivity1000 lineup, increasing hardware options and cost savings for small to mid-sized automation systems.



AutomationDirect is proud to announce that its Productivity1000 PLC series has been named an Honoree in the 2026 EDGE Awards in the Industrial Controllers category. The awards program, organized by EndeavorB2B, recognizes outstanding innovation in product design and function, with winners selected by readers of *Machine Design, Electronic Design, Power & Motion, Microwaves & RF, Automation World, Control Design, and Control.* Being named an Honoree underscores the continued relevance and impact of the Productivity1000 series in the industrial automation space.

Productivity1000 PLCs are known for their stackable design that features a base CPU with add-on I/O modules for easy expansion. This flexible ecosystem serves a wide range of applications requiring customizable I/O configurations, all housed in a compact form factor that requires minimal panel space and no base or backplane.

Recently, AutomationDirect introduced the Productivity1000 Mini PLCs, the first in the Productivity family to feature built-in I/O. These all-in-one units combine the CPU with discrete or analog I/O embedded directly on the CPU module. This provides an even more compact PLC option while still supporting up to four additional snap-on I/O modules, for a total of up to 80 discrete points or 40 analog channels.

With Mini PLC pricing starting at just over $100, the Productivity1000 delivers robust functionality at the lowest price point in the entire Productivity lineup. For small systems with light I/O requirements, the Mini PLC saves even more money by removing the need to purchase external I/O modules.

Both the classic Productivity1000 CPUs and the new Mini PLC units offer multiple wiring options for flexible installation. Models in both form factors have up to five built-in communication ports, including USB for plug-and-play programming, Serial RS-232 and RS-485 for Modbus RTU/ASCII or custom protocols, and Ethernet supporting Modbus TCP, EtherNet/IP, MQTT(S), and custom UDP/TCP connections.

Select Productivity1000 models can capture and store up to 32GB of historical data on a removable microSD card, enabling tag data and system event logging without additional hardware. The included Data Logger software makes configuration easy, and an integrated web server provides convenient access to historical data and real-time tag monitoring.

Complementing these capable hardware options, AutomationDirect's Productivity Suite programming software is available as a completely free download—no licenses, subscriptions, or hidden costs. This full-featured environment includes user-defined instructions, integrated version control, and an offline simulator. Automatic I/O module discovery generates I/O tags based on the positions of installed modules, minimizing tedious manual configuration and speeding the programming process.

Recognition as an EDGE Awards Honoree reflects AutomationDirect's ongoing commitment to delivering practical, affordable automation solutions trusted by engineers every day. Learn more about how the Productivity1000 series can streamline your next automation project at *https://www.automationdirect.com/productivity/p1000.*

To kick off their 75th anniversary, Bishop-Wisecarver launched a program called the 75 Acts of Giving Initiative, focused on honoring partnerships and giving back to the communities where their customers operate.

From October 2025 through October 2026, they recognized standout OEMs, ASPs, and integrators in each region for their long-term partnership and impact. Each honored company received a custom Bishop-Wisecarver 3D-printed robot award to mark this milestone. To extend this recognition even further, they also made donations to STEM-focused organizations local to each company's region in their name— supporting education, innovation, and the next generation of makers.

AutomationDirect was pleased to be named one of the June 2026 honorees and we were delighted that Bishop -Wisecarver selected GeorgiaFIRST Robotics as the charitable target for their donation.







Right on Cue: Automating the Voice Behind the Wagon Ride

BY JUSTIN HIEMSTRA, HEEMER CRAFTED

For agritourism drivers tasked with safely steering a tractor ride while holding their passenger's attention, automation helps keep the attraction story on track.



Modern hayrides combine transportation with entertainment to keep their guests engaged and satisfied. The vehicle operator must watch the road, mind the guests, and keep up a steady stream of jokes and facts, often over the rattle of a trailer and the drone of an engine. The job calls for one person to be both a safe vehicle operator and an entertaining tour guide, making it difficult to find and retain staff in an industry with brief operational periods due to seasonality.

Heemer Crafted, an automation and fabrication company based about two hours west of Toronto, has spent several seasons supporting agritourism operations across the region with technical solutions that enhance the guest experience. By bringing an industrial systems integration background to the farm, past projects have focused on stationary exhibits, such as animal sound boards, physics games, and animatronic props. But the newest project took that same automation toolkit and design philosophy and put it on the road.

Wagon and tractor rides remain a cornerstone attraction for many farms, but the driver's seat has always been the weak link in the experience. Solving that problem meant looking past the exhibit hall and into the cab. Unlike a fixed exhibit, a moving attraction adds its own set of constraints. Any system riding along on the tractor must survive vibration and weather while working with mobile-friendly power sources, all while staying simple enough for seasonal staff to operate it with minimal training.

Depending on the driver

Some of today's farms supplement their income and support the community by providing educational entertainment.

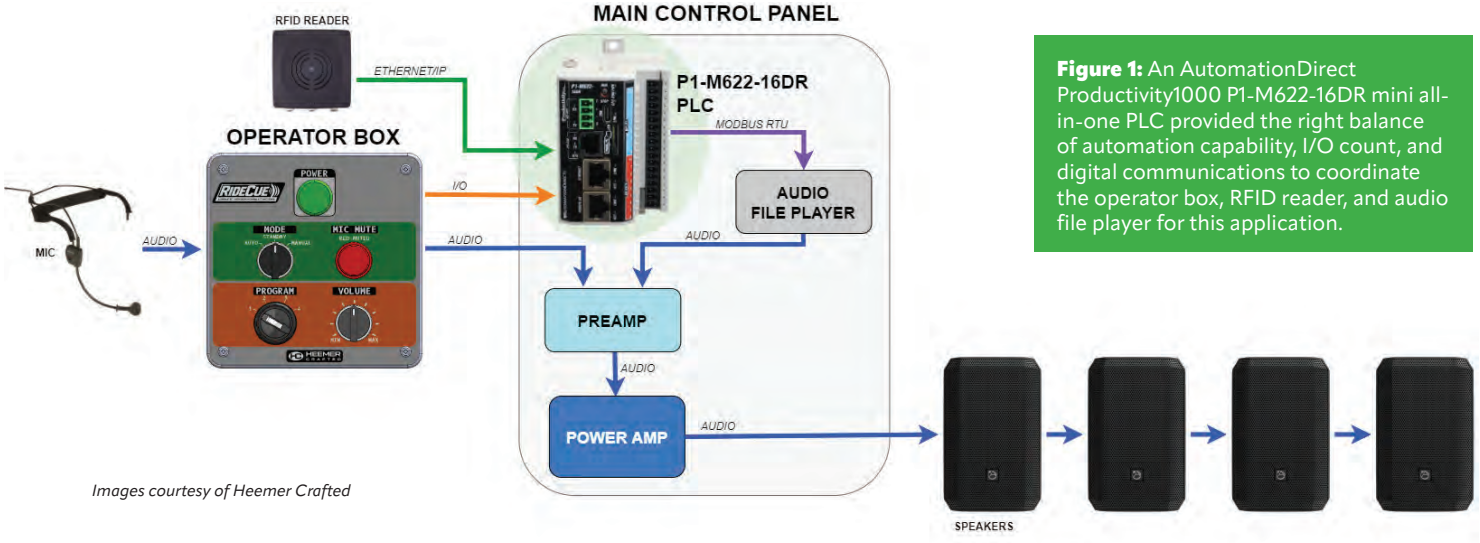


Figure 1: An AutomationDirect Productivity1000 P1-M622-16DR mini all-in-one PLC provided the right balance of automation capability, I/O count, and digital communications to coordinate the operator box, RFID reader, and audio file player for this application.

Images courtesy of Heemer Crafted

Images courtesy of Heemer Crafted

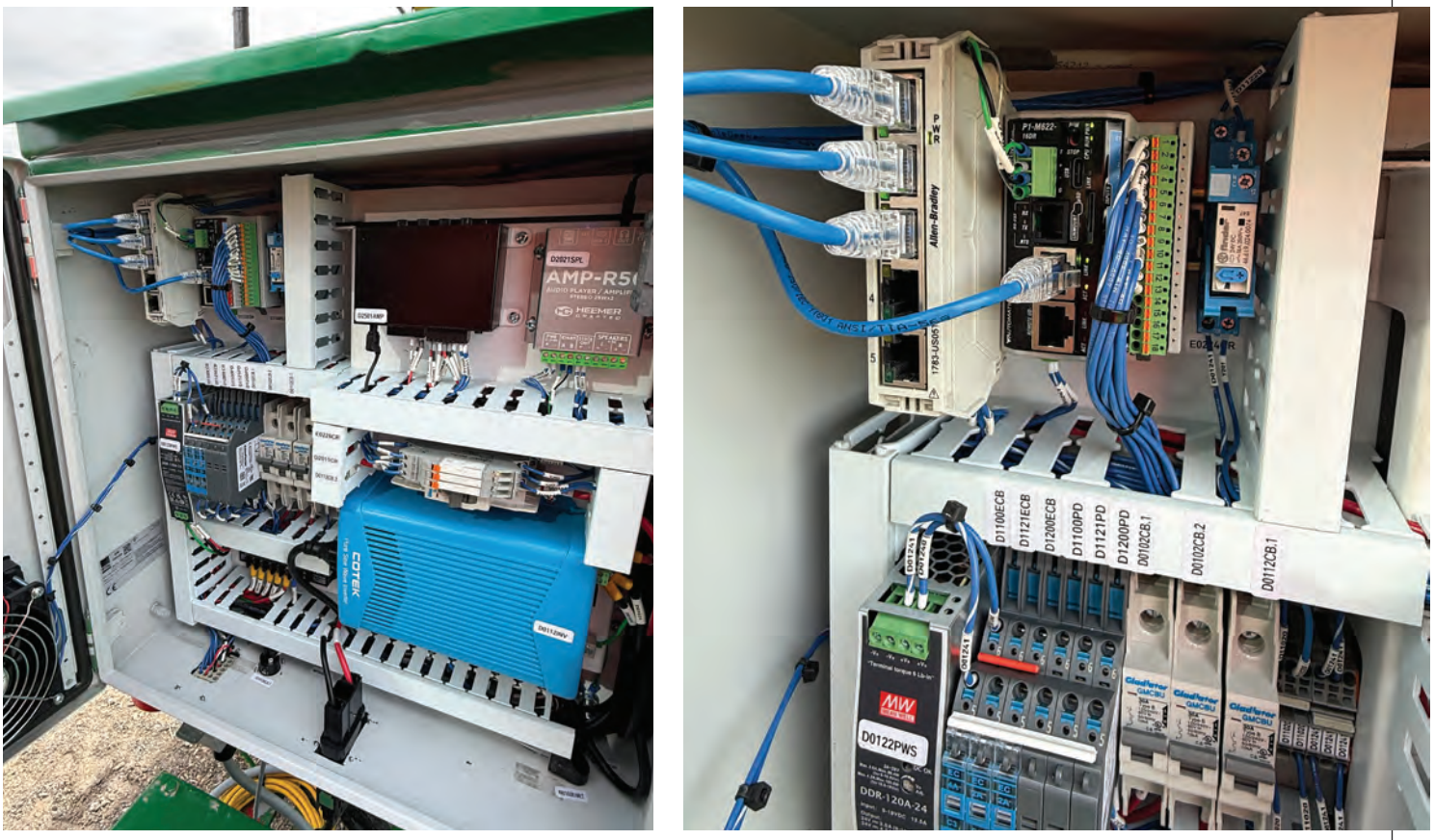


Figure 2: The compact AutomationDirect Productivity1000 PLC anchors a densely packed control enclosure, handling RFID communication, audio triggering, and cooling management within the limited space available on the trailer.

A tractor ride can transport guests throughout the operation, relying on the driver to deliver safety announcements, tell stories, and interact with guests throughout a ride. Finding someone who can drive safely, narrate confidently, and read a crowd is harder than it sounds, especially in an industry where much of the staff turns over annually.

Ride audio systems already on the market typically ask the driver to manually press a button at each stop to trigger the right track. That approach works only as well as the driver's attention and memory allow, and it adds one more task to a job that already demands full focus on the road, the trailer, and the guests behind it. Furthermore, these systems are often limited by the number of buttons/messages available.

These issues can create an inconsistent guest experience from ride to ride, plus a training burden repeated every season as new drivers rotate in. A system built around manual cues was never going to close that gap because it still puts most of the guest experience in the hands of whoever happened to be driving that day.

Scripting the solution

Rather than relying on a driver to remember when and what to play, the design goal shifted toward triggering narration automatically based on the tractor's position along the route. This would allow the driver to stay focused entirely on operating the vehicle, while the audio experience ran itself in the background.

Delivering on that goal required a control platform that could sit unattended behind the scenes, read a location signal reliably, and drive playback equipment without missing a cue. The platform also needed to survive outdoors in an open-cab tractor through a full farm season of dust and weather.

That combination of requirements led to the creation of RideCue, an automated ride audio system built by Heemer Crafted specifically for moving attractions.

Based on many previous projects, Heemer Crafted staff knew that an industrial-grade programmable logic controller (PLC) platform would be the right choice for an automation platform, instead of a consumer-grade microcontroller or some other device more suited for the general entertainment industry. A PLC is compact, built to withstand harsh environments, and can operate on the DC power typically available on vehicles and from solar panels. The PLC would need to handle standard wired signals, and various Ethernet and serial communication protocols to interact with other intelligent devices.

Wired for a roadshow

An AutomationDirect Productivity1000 PLC was selected to handle the RideCue environmental and functional requirements. While this product >>

Images courtesy of Heemer Crafted





Figure 3: Mounted directly on the wagon and paired with a solar panel, the weatherproof RideCue automation system withstands dust, moisture, and temperature swings—while running independently of the tractor's battery.

"A PLC is compact, built to withstand harsh environments, and can operate on the DC power typically available on vehicles and from solar panels"

family is generally known as an expandable "stackable micro" form factor, there is now a newer "mini" series which is an all-in-one solution with on-board input/output (I/O) points. Because enclosure space on the trailer was tight, the compact footprint of this PLC style mattered as much as its processing capability (Figure 1).

Inside the cab, the operator interacts with RideCue using a compact control panel mounted near the driver's seat. A mode selector is used to switch between automatic operation and standby, with a provision for manually enabling the headset microphone when needed. A program selector switch allows the operator to choose one of four programs, and a volume knob lets the driver adjust the guest experience on the fly without taking their eyes off the road for long.

Cultivating more stories

A location-triggered system backed by a PLC and audio file player provide a great deal of flexibility. As the tractor passes by designated points along the route, a radio-frequency identification (RFID) reader mounted on the vehicle detects a tag installed in the field and reports it to the control panel using EtherNet/IP via the PLC's Ethernet communication port. From there, the controller instructs a dedicated audio file player over Modbus RTU, a serial communication protocol, to play the track assigned to that location. The sound plays through a

preamp, a power amplifier, and a chain of weatherized speakers mounted along the wagon (Figure 2).

For this tour operator, the route uses up to 20 tags to trigger audio files, though the RideCue platform itself supports up to 100 tags per installation. The tags stay fixed along the route year-round; it's the audio library that changes with the turn of the program selector switch, which chooses between four seasonal programs to support different experiences, such as spring, summer, a fall harvest experience, or even a nighttime haunted ride. In addition, two playback variations are layered onto each program, meaning every tag along the route can voice up to eight different sounds. That gives this operator up to 160 different sounds so guests who ride more than once can hear a different story, joke, or character interaction. A 100-tag system supports as many as 800 sounds.

Expanding the route is just as straightforward. Adding a new stop or scene just requires loading new audio files onto the system's SD card and installing another RFID tag in the field, with no special software, reprogramming, or manufacturer support required. RideCue also gives attractions new opportunities for storytelling. Farms can add static props, animatronics, themed scenes, or characters throughout the route, with RideCue automatically triggering narration, dialogue, or sound effects at the correct location. This helps transform a standard wagon ride into a more immersive attraction.

Weathering the ride

Agritourism attractions run outdoors, in conditions that would be unkind to consumer-grade electronics, including dust, vibration, moisture, and wide temperature swings as they bounce down a farm lane during the season. RideCue's control enclosure is built from industrial-grade, weather-resistant components to survive that environment, and the operator controls are designed to work without a cab or awning since many farm tractors run open-station.

A solar-powered configuration, available alongside an externally vehicle-powered option, keeps the system running independently through the day without drawing down the tractor's battery. The PLC quietly manages other important functions — such as enclosure cooling, amplifier muting during idle periods, and placing the inverter into standby — to conserve power for solar-powered installations (Figure 3).

In addition to the PLC, most other project components — such as the enclosure, cooling fans, thermostat, circuit breakers, connectors, pushbuttons, and even the Swivellink control panel mount — were sourced from AutomationDirect. Real-time pricing and stocking information on the website made it possible to plan a build with confidence, and downloadable CAD files for individual components made panel layout far easier than working from datasheets alone.

This type of dependable sourcing is critical for a design that can't afford downtime once it's in the field. A farm's ride schedule doesn't even leave much room for troubleshooting during a busy weekend. Free programming software and no per-seat licensing fees also keep the overall cost of the control platform down, which matters for a small company building custom systems in limited runs rather than in mass production quantities.

With the narration running itself right on cue, every time, the driver can improve their focus on safety, watching the road, and supervising the passengers. Guests get a consistent, well-timed story on every ride, whether the driver is a ten-season veteran or someone hired for the summer. Heemer Crafted plans to keep building on the platform, adding new program content and looking at other moving attractions where the same automated approach could be used to safely improve the guest experience.

Justin Hiemstra, *founder and dedicated employee of Heemer Crafted, combines his expertise in engineering and design to create innovative, engaging, and entertaining attractions in the agritourism sector. Leveraging an educational background in mechanical engineering technology, with a specialized focus in robotics and automation, Justin has built his career focused on blending industrial technology with creative problem-solving. Justin left his previous role at a systems integration firm to further pursue his passion for creating designs supporting the creativity, learning, and exploration of the next generation.*

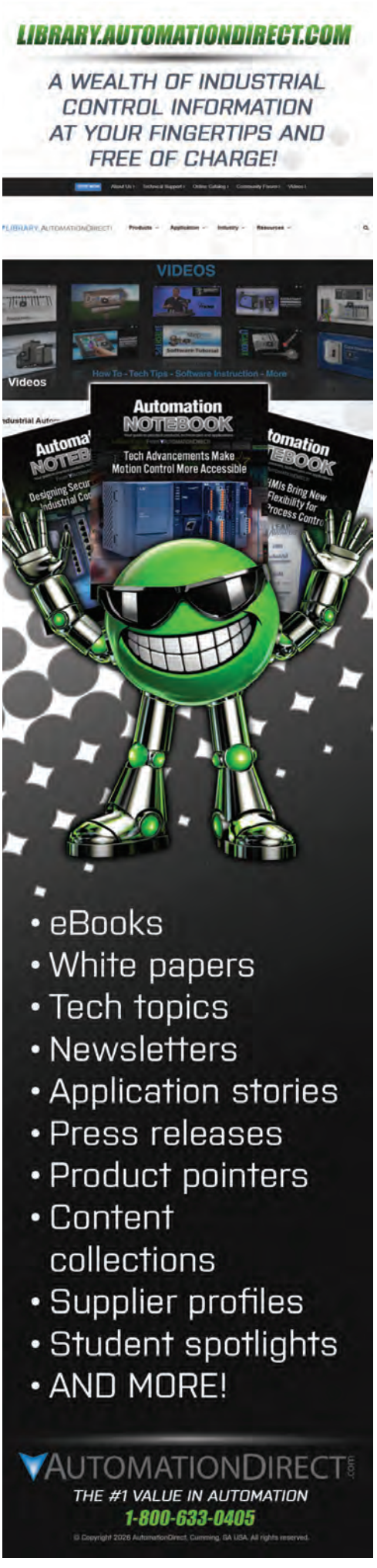




Image courtesy of AdobeStock

DESIGNING INDUSTRIAL SYSTEMS FOR GRACEFUL RECOVERY WHEN MACHINE FAULTS OR COMPONENT FAILURES OCCUR

BY ALEX MAERCZ

A machine rarely operates alone or under ideal conditions. Sensors fail, drives trip, networks drop out, and upstream equipment becomes unavailable. The controls architecture determines whether one of those events causes a brief slowdown, a safe stop, or an unplanned shutdown requiring hours of troubleshooting.

Automation Notebook recently spoke with Alex Maercz, product engineer at AutomationDirect, about designing machines to respond predictably to adverse operational conditions and recover quickly if performance is compromised. Alex spent most of a decade building packaging machines and another decade running them in 24/7 production, giving him experience on both sides of the OEM-customer relationship.

What does graceful recovery mean in practical machine-control terms?
It means the design team has considered what should happen when something does not work as intended. OEMs are under pressure to deliver a line quickly, but that schedule is only one measure of success. The customer needs a machine that will run for decades with little downtime and recover without requiring an operator to understand everything happening behind the controls.

The recovery process also has to be tested. An e-stop is the most straightforward example: motion must stop immediately, but what happens next distinguishes a good machine. It may recover automatically, or the HMI may guide the operator through inspections and product removal before restart. A former boss of mine would wait until a new machine was running and hit an e-stop. I hated it the first time, but I learned that he was testing whether we had programmed for the event rather than assuming recovery would work.

That planning takes more engineering time before shipment, but it is a one-time cost. If a controls engineer spends eight hours identifying the initiating fault, defining the response, and writing a useful message, the machine can avoid repeating that troubleshooting during every outage. Passing factory and site acceptance tests shows that a machine operates under test conditions. The customer's judgment comes after turnover, when wear, dust, and intermittent production expose conditions the design team did not encounter during commissioning.

How should machine builders decide whether their control systems should stop equipment immediately or continue at reduced capacity?
The answer has changed as fewer operators oversee more machines. If a noncritical fault allows safe operation at reduced throughput, keeping the machine running may be the best response until someone can attend to it. The machine should attempt an automatic recovery where practical and clearly announce that production has been reduced. Stack lights work well for that purpose, while horns should be used sparingly so operators do not learn to ignore them.

The machine should stop when personnel safety is involved, continued operation could damage equipment, or product and raw material would be wasted. For example, a process should not keep making material that must be cured within a set time if the downstream oven has failed. The response has to reflect the entire production system, not the machine in isolation.

How should a machine respond to a failed sensor or drive?
For a sensor, monitor the transitions the process expects. If a sensor should turn >>

"The required response to a SCADA failure should be agreed upon before the machine is built. Some facilities require equipment to stop if SCADA becomes unavailable."



Image courtesy of AutomationDirect

on or off at a certain point and does not, the controller should recognize the missed transition rather than wait indefinitely. If another process path is available, the machine may continue at a lower rate. The HMI should identify what failed and show where the sensor is located. A name or tag number may not mean much to someone facing a large machine at 2:00 a.m.

A failed drive will usually require a stop because continued operation may put the machine at risk. Most drives provide detailed fault information, and that information should appear in an understandable form on the HMI. An overtemperature alarm, for example, may point maintenance toward a worn ball screw that is increasing the drive load. If the drive must be replaced, the ideal design automatically sends the correct configuration to the new unit. Then test that behavior with a factory-new replacement before the machine enters production.

If a network connection or upstream system is lost, what should remain available locally?

Separate the local fieldbus from the upstream, downstream, and management network as much as possible. If the local fieldbus fails and the machine cannot function properly, use defined retry logic. If retries fail, stop the machine and identify the communication failure while suppressing the secondary alarms it caused. Repeated successful retries should still generate a warning because they may reveal a problem before it forces downtime.

Connections to other machines and SCADA systems need handshakes or heartbeat signals that confirm the remote system is available. When another machine goes offline, finish processing in-flight product where practical, then enter a holding state that supports automatic resumption. The logic may also need to churn material, maintain a standby temperature, or discard material that has become unsuitable.

The required response to a SCADA failure should be agreed upon before the machine is built. Some facilities require equipment to stop if SCADA becomes unavailable. Others expect the machine to keep running and buffer data for later retrieval. Leaving that decision until commissioning usually produces a rushed workaround.

What should restart logic verify before production resumes?

The machine should use sensors to determine its complete state, including the location of any in-flight product. Restart logic then needs a reliable way to return the equipment to a known good state, ideally through one operator command. Where sensors cannot determine a condition, the HMI should tell the operator what to inspect.

Required inspection steps should be verified where practical. The controller might confirm that a specified enclosure was opened or that the sensor named in the instructions changed state. This provides evidence that the check occurred before motion or production resumes.

What design mistakes can turn a minor failure into extended downtime?

Weak handshakes between connected systems and failure to monitor sensor transitions are common causes. Wiring should also fail in a safe direction. A normally open high-level switch, for example, may never report a full tank after a wire break, allowing an overflow. Conversely, a normally closed arrangement can issue a false alarm when the wire breaks, but it prevents the tank from overflowing.

Another mistake is displaying every secondary fault after the first failure. That alarm avalanche hides the root cause and costs maintenance time on every occurrence. Read all available device status information, display the initiating fault clearly, and use the PLC or IO-Link master to configure replacement devices automatically where feasible. Finally, disconnect a component or network during testing. That uncomfortable step is the only way to confirm that the planned response and recovery actually work.

How can AutomationDirect support graceful degradation and recovery?

Before AutomationDirect offers a component, we test its alarm signals and verify that they work as expected and are documented clearly. Alarm behavior sometimes receives less attention from manufacturers than a device's primary function, yet customers need that information to design a useful response.

Our PLCs also expose the status information engineers need to detect abnormal conditions, explain them through the HMI, and keep recovery time low. The goal is to give OEMs, systems integrators, and industrial engineers the information and controls needed to build machines that respond predictably when a component fails.

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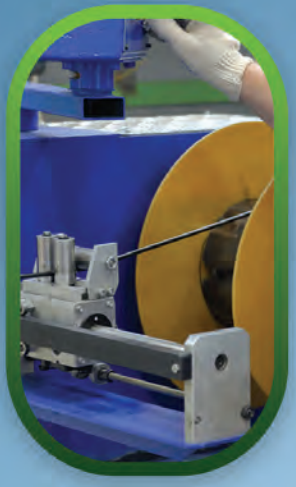
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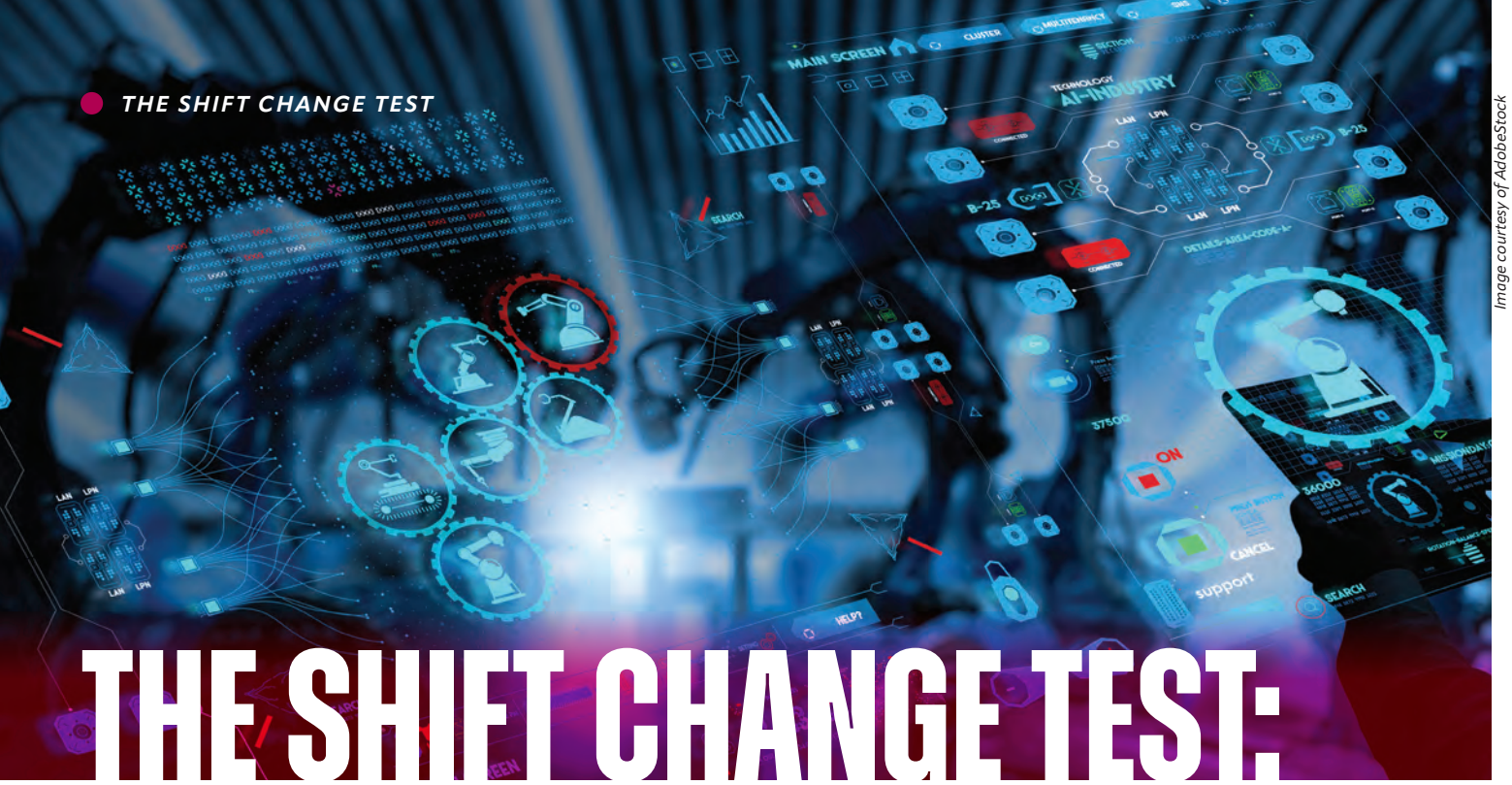


Image courtesy of AdobeStock

THE SHIFT CHANGE TEST: CAN YOUR MACHINE EXPLAIN ITSELF?

By substituting sensor data and analytics for tribal knowledge, self-explaining machines streamline recovery, enhance productivity, and share expertise.



BY BILL DEHNER, AUTOMATIONDIRECT

It's 6:58 PM. The day shift is heading home and the night crew is taking over. A machine has had a few intermittent faults throughout the day. "It's been acting up but we got it running," the outgoing operator says. "Just keep an eye on that encoder."

Six hours later, the machine faults out. Red error codes flash. Nobody remembers which encoder was the problem. Nobody knows the workaround. It's the middle of the night and a call goes out to maintenance. Nearly 45 minutes passes before troubleshooting even starts.

Far too many organizations rely on tribal knowledge, unwritten tips and tricks frequently known only by one or two experts. "Rick knows how the palletizer works." "Paula knows the reset sequence." The problem arises when Rick or Paula retires, changes jobs, goes home for the night, or transfers to a different facility. The problem arises when Rick and Paula are too busy fielding question after question from people seeking their expertise to do the expert work that only they can do.

The best machines communicate their condition, history, problems, and next steps clearly enough that an incoming operator, technician, or maintenance engineer can quickly understand:

- What the machine is doing
- What it was doing previously
- Why it stopped
- What hardware and/or software needs attention
- What happened during previous shifts
- How to recover safely

What happened during the previous shift in our example was a loss of encoder-drive communications caused by transient EMI. The short-term fix was executing a simple reset sequence, but the information was never passed along. Instead, what should have been a 30-second recovery stretched to almost two hours of unscheduled downtime, plus overtime for the maintenance technician.

A machine isn't truly optimized if its performance depends on a specific person being available to explain what's happening. If the answers require finding a certain person who's the machine whisperer, then uptime is at risk. This is the shift-change challenge: Can your machine explain itself?

What are the characteristics of a Self-Explaining Machine?

A self-explaining machine shows machine health

A self-explaining machine should provide a quick reference snapshot giving current state, production rate, device

health, overall equipment effectiveness (OEE) indicators, fault conditions, and maintenance status. The goal is that a single screen should provide the answers to the essential questions an operator or technician would ask.

A self-explaining machine identifies problems clearly
A bad error message simply gives an error code that has to be looked up, assuming there is a manual available or stored in the HMI. A self-explaining machine provides clear descriptions of any issues:

> *Error: Conveyor jam detected – product not cleared within 15 s*

This is a significant improvement but still leaves the operator or maintenance tech with no specific direction of what to do next. An optimal message would display both cause and recovery steps in straightforward language:

Error: Conveyor jam detected

1. *Check photo eye PE-03 at discharge station.*
2. *Remove obstruction and press Reset.*

A self-explaining machine preserves context
The circumstances that lead to a fault provide the foundation for troubleshooting. Staff should be able to easily and quickly find the answers to questions like when the fault happened, whether it's a recurring issue (and if so, how frequent). Most important, they need to know the operating conditions and activities immediately prior to the fault. This context can be gathered from a combination of alarm history, event log/data logging, and diagnostic screens. Instead of settling for an operator saying, "I think it started acting strange sometime yesterday," maintenance should be able to call up the record and see that the issue began at a certain date and time, after a specific operation.

Building a self-explaining machine
Industry 4.0, with its emphasis on digitalization and data-driven insights has fostered the technologies for smart factories and self-explaining machines.



Image courtesy of AutomationDirect

Figure 1: BRX series PLCs from AutomationDirect provide IIoT integration, data logging, motion control, and processing capacity, with customizable communications. BRX CPUs come standard with 1MB of internal RAM plus up to 32GB of data storage on an optional, removable microSD card. Pluggable option modules (POMs, inset) extend support to MQTT Client, FTP Client, OPC-UA, EtherNet/IP, and more.

Smart components
Adding onboard processing power and memory equips critical components to monitor themselves and maintain a record. Today's smart devices and networked machines have the ability to capture, store, and present detailed condition and operating data.

Encoders: Onboard diagnostics can monitor not just temperature but more sophisticated metrics like the number of power-on sequences, hours of powered operation, hours the encoder is actually in motion, number of direction changes, etc. The results can be exported or stored onboard so that in the event of failure, maintenance can access a detailed record of events leading up to the failure. This is particularly important because encoder-related issues can often lead to drive faults.

Drives: Diagnostics for modern smart drives monitor not just the drive itself but motor-related quantities like overcurrent, overtemperature, overvoltage, and communication loss. Increasing drive current to maintain a specific torque can indicate issues with the bearings, gearbox, or motor, for example. Many drives incorporate data loggers with rolling buffers that can store events and conditions in place prior to a fault. A key instruction is to capture any data from the buffer and fault log before resetting, as resets can clear the buffer in some models. That should be one of the first recovery instructions noted after the error description.

The Shift Change Test

Imagine a new operator walks up to your machine. Can they easily get the answers to the following questions?

1. **What is the machine doing right now?**
2. **Is it producing normally?**
3. **What stopped it last?**
4. **What alarms have occurred recently?**
5. **Which device(s) caused the fault?**
6. **What steps should be taken to recover safely?**
7. **Where are those instructions?**
8. **Can maintenance identify a failed component quickly?**
9. **Can they understand the system without calling an expert?**

If several answers are "no," the machine may be costing more downtime than its OEE reports reveal.

Other sensors: Modern machines and process equipment have increasing numbers of sensors for tasks like process monitoring, machine monitoring, and environmental monitoring. They include temperature sensors, pressure sensors, hygrometers, vibration sensors, proximity sensors, optical sensors, machine vision, etc. These devices can be configured to automatically relay data to the PLC or SCADA system for reporting and diagnostic purposes, especially when they take the form of data loggers. >>

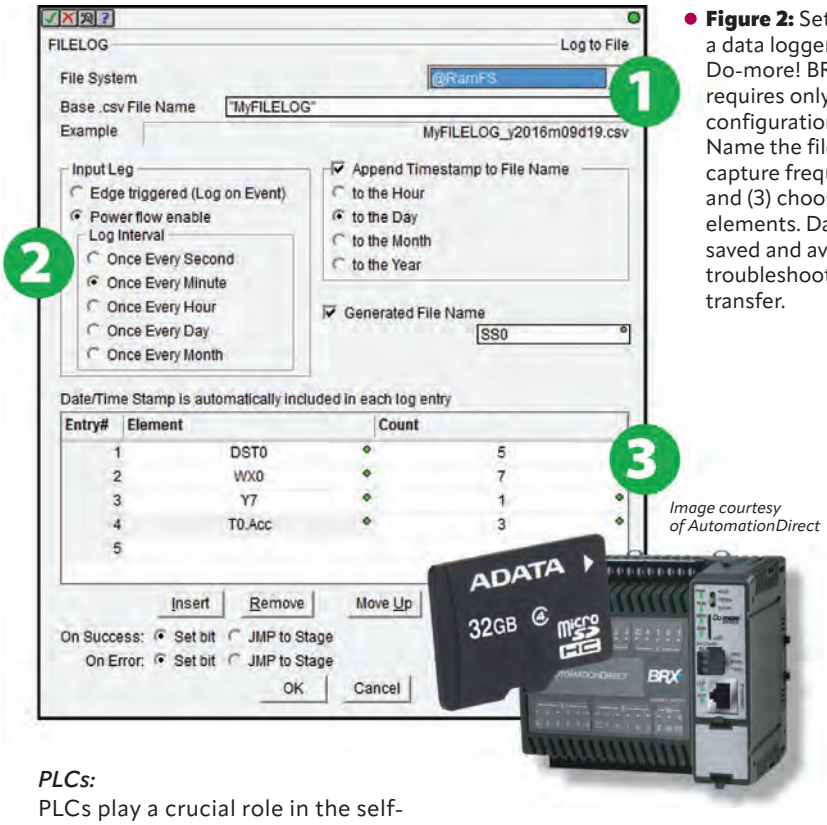


Image courtesy of AutomationDirect

● **Figure 2:** Setting up a data logger in the Do-more! BRX platform requires only three configuration steps: (1) Name the file, (2) select capture frequency, and (3) choose data elements. Data will be saved and available for troubleshooting or FTP transfer.



Image courtesy of AutomationDirect

● **Figure 3:** CM5 HMI series from AutomationDirect features 1.6GHz processors in larger units, as well as extra data storage and faster communications. These HMIs can handle a variety of file types including JPEG to support self-explaining machines. CM5 HMIs support many of the protocols found in IIoT-capable systems including FTP, HTTPs, and MQTT(S).

PLCs:
PLCs play a crucial role in the self-explaining machine. While smart devices like drives can be configured to send error codes and alerts directly to the HMI, PLCs more commonly aggregate device input. As the central machine controller, the PLC can convert that input to programmed diagnostic messages, then send it to the HMI for display (see Figure 1). They frequently incorporate not just memory but data loggers to maintain alarm history and event logs. When connected as an edge device, a PLC can transfer that data to SCADA systems for further analysis.

Look for PLCs with built-in data loggers that only need configuring to be operational (see Figure 2).

An important step is to apply the self-explaining principles when programming the PLC with alerts and diagnostic messaging. The wording of these messages and decisions about what gets displayed should be approached as a communications opportunity. In the event of a fault, as the examples above show, alarm messages should be written in plain language, describing faults in ways that can be understood without the need for a manual. It should assist operators in identifying likely causes of the fault and show them clear instructions for troubleshooting and/or recovery.

The machine network
None of this would happen without the machine network to support communications among devices, PLC, and HMI. The machine network may take the form of a traditional fieldbus like Modbus or CAN or it may be one of the many industrial networking protocols that have sprung up over the past two decades. Another useful offering is MQTT(S), a lightweight protocol well suited to harvesting data from industrial internet of things (IIoT) devices like field sensors.

Designing HMIs for the next shift

The final, and in many ways most important element of the self-explaining machine is the HMI. To meet the shift-change challenge, the role of the HMI needs to be completely rethought. It needs to go beyond just displaying menus or codes. It needs to transfer knowledge.

Ideally, critical status, condition, and diagnostic information should be accessible with a single tap (see sidebar). We've already talked about how to optimize communications for information transfer, but today's large form factor HMIs can also include detailed graphics to not just tell users where to find the problem devices but also show them (see Figure 3). Modern HMIs have more memory, enabling them to store not just data but documentation.

Conclusion

Poor communication across shifts is the hidden OEE killer. Every undocumented workaround is future unscheduled downtime waiting to happen. Every cryptic alarm and hidden troubleshooting activity slows recovery and increases dependence on a limited pool of experts. A well-designed machine should not depend on tribal knowledge to operate effectively. It should communicate its status, explain its problems, guide users toward resolution, and preserve the information needed for the next operator, technician, or maintenance engineer. When a machine can explain itself, shift changes become smoother, troubleshooting becomes more efficient, and uptime becomes easier to sustain.

To learn more about how to make your machine pass the shift-change tests, reach out to the automation experts at AutomationDirect. We carry a comprehensive line of high-performance, budget-friendly equipment to make your next project a success.

Bill Dehner *has spent the majority of his engineering career designing and installing industrial control systems for the Oil and Gas, Power, and Package Handling industries. He holds a bachelor's degree in electrical engineering with an associate's degree in avionics from the USAF and is currently working for AutomationDirect as a technical marketing manager.*

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CLICK PLUS Add-On Modules Push Node-RED and OPC UA to the Edge

AutomationDirect's option modules expand the CLICK PLUS PLC platform without impacting deterministic control, giving users plug-in edge capabilities — dashboards, cloud connectivity, and standards-based data access — without additional edge gateways or IPCs.



GREG PHILBROOK, AUTOMATIONDIRECT

Today's machine and process skid builders and OEMs are tasked with more than delivering reliable and deterministic performance. End users are also calling for effective ways to extract data from the programmable logic controllers (PLCs), and to then transport the resulting information to other local and cloud-based computing platforms for dashboarding, analytics, and other value-adding functions. A common approach has been to layer-on separate gateway devices or industrial PCs, which can do the job but also drive up the cost and complexity of deployment and support, along with expanding the required footprint.

AutomationDirect has answered this challenge by offering add-on modules for the CLICK PLUS stackable micro modular PLC platform (Figure 1). The C2-NRED for Node-RED and the C2-OPCUA for OPC UA are available to plug directly into the CLICK PLUS backplane, adding edge computing power alongside, not instead of, the proven deterministic control logic already controlling the machine or process skid. Neither module requires an OEM to abandon an existing CLICK PLUS design or move to a different controller family to gain edge capability.

> **"Node-RED is a free, open-source, drag-and-drop, low-code tool for wiring together data flows among hardware, APIs, and cloud services."**



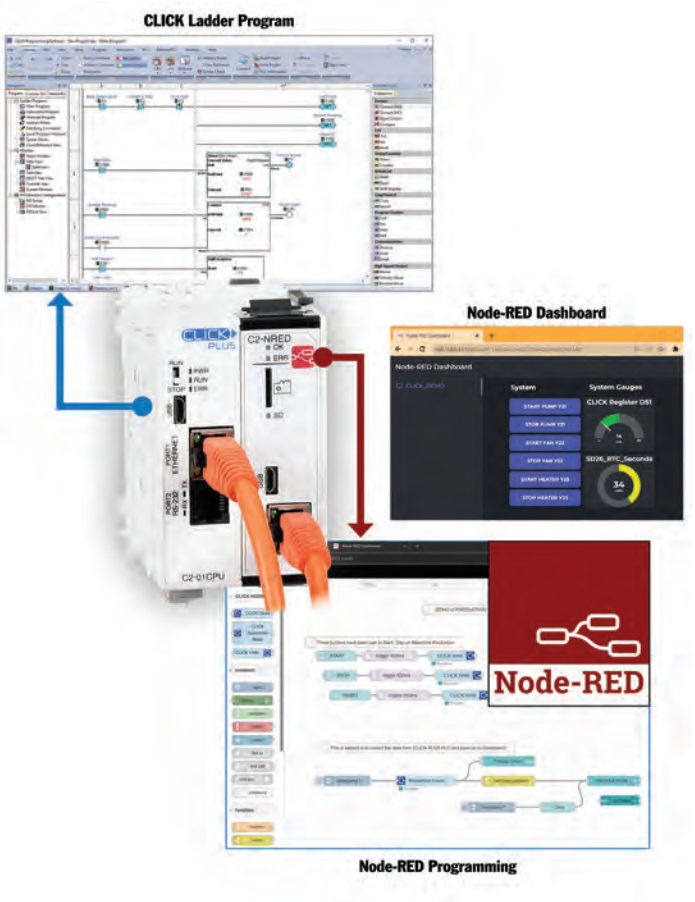
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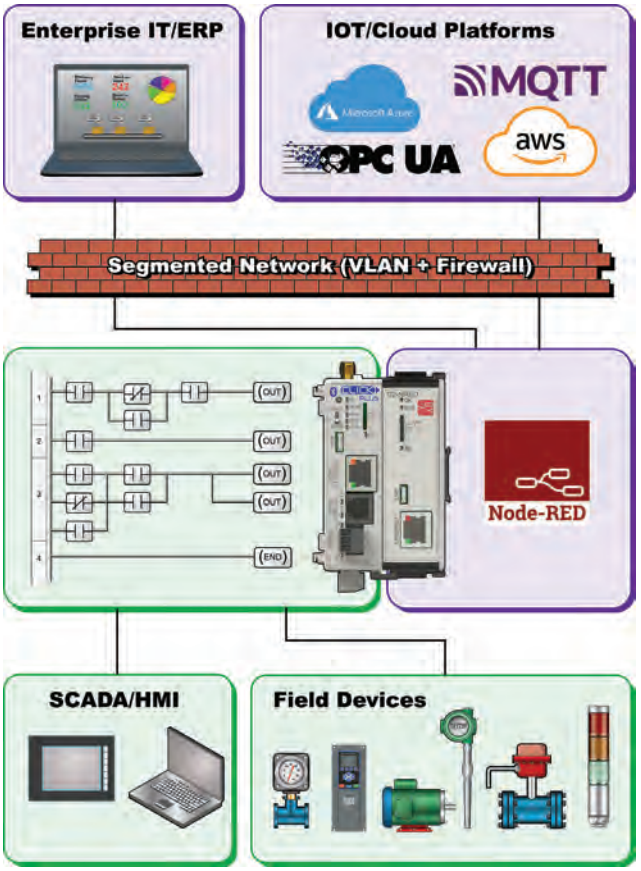
Figure 1: The AutomationDirect C2-NRED or C2-OPCUA module plugs directly into the CLICK PLUS backplane, adding its own processor and Ethernet port for secure data connectivity, while preserving the PLC's real-time control capability.

Low-code data flows

Node-RED is a free, open-source, drag-and-drop, low-code tool for wiring together data flows among hardware, APIs, and cloud services. Thousands of ready-made nodes and example flows for input/output, data processing, logic, and even social media functions are available at https://flows.nodered.org/. AutomationDirect maintains its own library of CLICK-specific examples and tutorials at www.automationdirect.com/videos/home.

The C2-NRED module hosts a full Node-RED runtime on embedded Linux, and because the module reads PLC data straight off the backplane, there are no modifications required to existing control programs, with a live dashboard, MQTT publishing, or similar connectivity provided (Figure 2).





Images courtesy of AutomationDirect

Figure 2: CLICK PLUS ladder logic and the Node-RED programming run in independent environments, so both controls and connectivity experts can use familiar tools. MQTT, Microsoft Azure, AWS, and OPC UA are trademarks or registered trademarks of their respective owners. All trademarks are acknowledged and used with permission.

A built-in, standards-based server

OPC UA is a platform-independent, service-oriented communications architecture, standardized internationally as IEC 62541 and maintained by the vendor-neutral OPC Foundation. It is built for structured, secure data exchange among PLCs, human-machine interfaces (HMIs), supervisory control and data acquisition (SCADA) systems, manufacturing execution system (MES) platforms, and other network/cloud applications, with authentication, encryption, and contextualized data built into the protocol itself rather than layered on afterward.

The C2-OPCUA module turns a CLICK PLUS system into an OPC UA v1.04 server, supporting up to 1,024 data nodes and five simultaneous client connections, configured entirely in the free CLICK PLUS programming software and stored with the PLC project for easy recovery after a firmware update (Figure 3). Security options include an IP allow list, username/password authentication for up to eight accounts, Sign and Sign & Encrypt policies, and self-signed certificates from 1,024 to 4,096 bits.

Separation as a security strategy

Both modules share the same underlying architecture, with a dedicated processor communicating with the PLC CPU over the high-speed backplane to independently handle all IT-facing traffic, such as MQTT, HTTP, and OPC UA sessions, and also connections to platforms such as Microsoft Azure, AWS IoT, or an on-premise broker like Mosquitto. The CPU keeps its fixed scan cycle and full deterministic performance, while the module absorbs the connectivity workload, so a runaway edge application or a busy cloud link can't slow the real-time control.

Because the Node-RED and OPC UA modules each have a dedicated Ethernet port they can be connected

> **"The CPU keeps its fixed scan cycle and full deterministic performance, while the module absorbs the connectivity workload, so a runaway edge application or a busy cloud link can't slow the real-time control."**

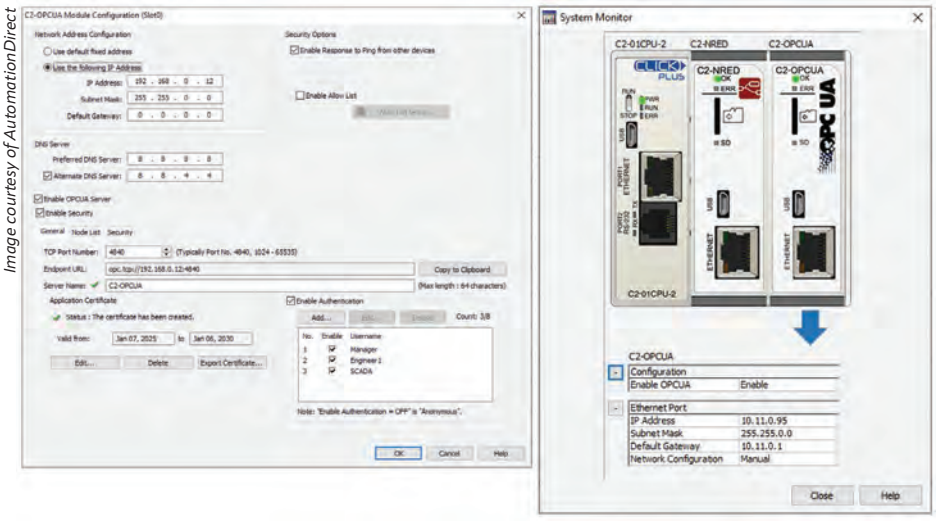


Image courtesy of AutomationDirect

Figure 3: Communications module configuration — the OPC UA module is shown here — includes IP addressing, security policy, and authenticated user accounts, all set up via the free CLICK PLUS programming software.

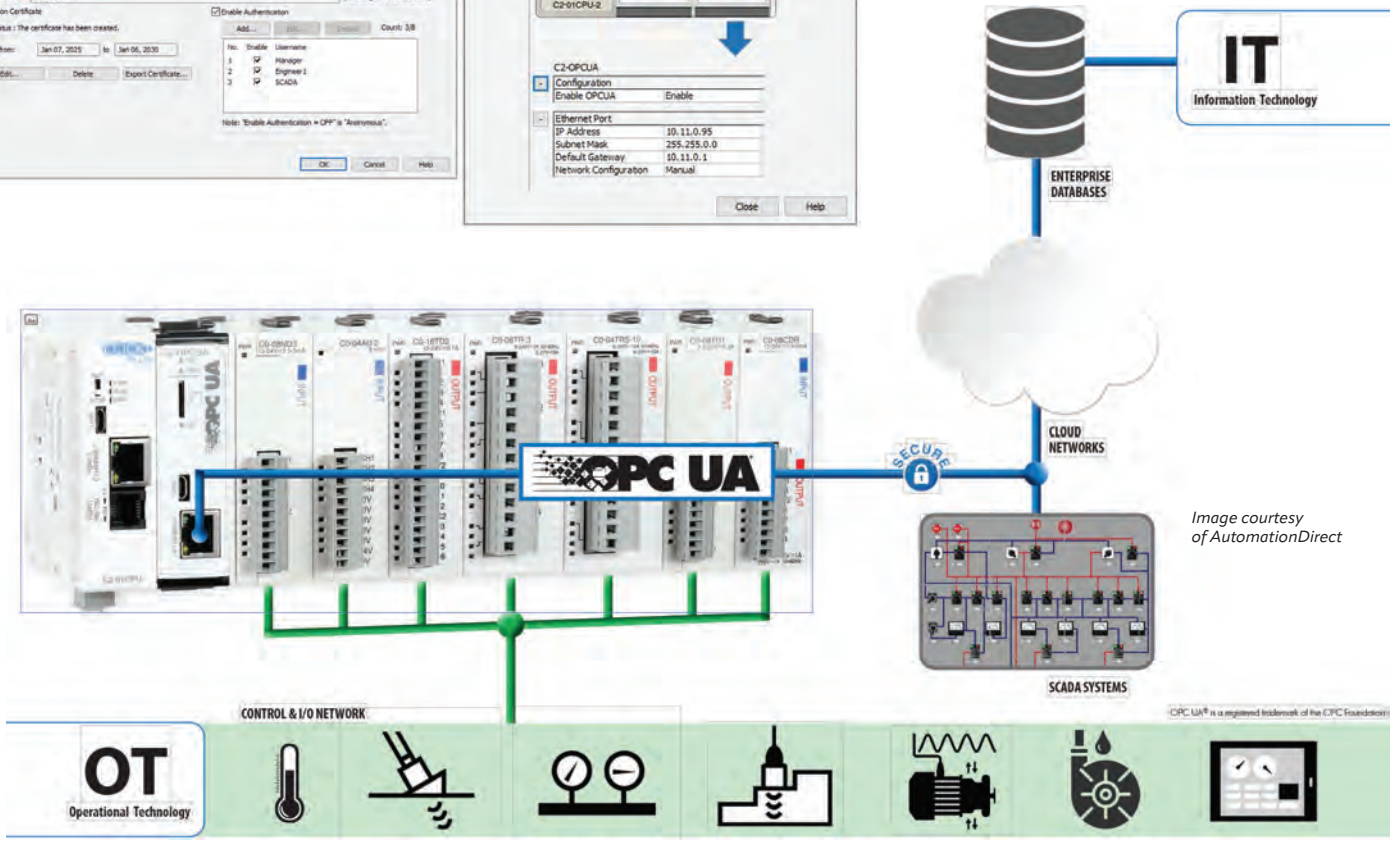


Image courtesy of AutomationDirect

Figure 4: The C2-OPCUA module gives a CLICK PLUS system a standards-based path from field devices and SCADA up to enterprise databases and cloud networks.

to a specific subnet or VLAN, forming a natural demilitarized zone between the control network and the enterprise network (Figure 4). Both modules carry a UL listing, CE marking, and other certifications, and they share the CLICK PLUS platform's DIN-rail-mounted enclosure ratings, including a 0° to 55°C operating range.

Easily add open edge capabilities

For small and mid-sized OEMs, the Node-RED and OPC UA add-on communications modules make it easy to add edge communication capabilities to an existing or new CLICK PLUS system, while preserving proven ladder logic functionality. Both modules are supported and firmware-updated directly by AutomationDirect rather than tied to a third-party Linux distribution schedule, which is important for equipment with a 10- to 20-year service life.

Whether the project needs a lightweight visual flow built with Node-RED or a standards-based OPC UA server, the CLICK PLUS C2-NRED and C2-OPCUA modules put secure edge connectivity within reach of applications that could never otherwise justify a separate gateway or industrial PC.

Greg Philbrook *is a product manager at AutomationDirect. He is responsible for product strategy, specifications, and development for the CLICK PLC product line. In Philbrook's 30+ years with the company he has worked in several roles including technical sales, support, engineering, and development.*

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An In-House Fix for an Aging Forge Control System



This plant's maintenance team replaced an unsupported control system for their crankshaft forging line, using proven automation components.

BY JERRY SHUMAN, THYSSENKRUPP

Thyssenkrupp forges crankshafts for the automotive industry, and like any heavy manufacturing operation the plant runs best when the equipment keeps moving. When necessary, the site has relied on outside integrators for automation upgrades or improvements, but more recently the approach has evolved toward doing as much as possible in-house. This not only keeps costs down, but it keeps the knowledge of how the system actually works inside the building, and enables the team to create exactly the functionality they want.

One place that philosophy paid off recently was the final cleaning and inspection cell, where critical steps are performed before a forged crankshaft gets cleared (Figure 1). A shot blasting machine pummels the castings with steel shot to remove scale, while a magnetic particle inspection station will reveal any unacceptable cracking. Robots move the castings around the cell, and a dust collector protects the area. The brains of the system are within a central control panel that ties all the pieces together.

An aging system, out of support

The original control system had reached its end of life. Many components, including the programmable logic controller (PLC) and human-machine interface (HMI), were no longer supported, making spare parts scarce and risky for daily operations. Reliability was the bigger day-to-day headache. The cell racked up a lot of downtime, much of it from nuisance faults like ASi bus errors, and emergency stops (e-stops) tripping for no good reason. It had reached the point where the cost of continuing to fix the system outweighed that of a full replacement.

Adding to the age of the controls, there was a mechanical wear problem that was exacerbated by the type of motor control the old system used. The eight motors that throw the shot inside the blast cabinet, each a 50HP/55A unit, were started across the line. Slamming these motors on and off is hard on the equipment, and over time it takes a toll.

All of this pointed to a full control system replacement. The plant already had quotes from outside integrators to do the same work, and they were steep. Rather than accept those numbers, I put together a rough engineering package with everything needed for a complete replacement specified along with cost estimates. Set against the outside quotes and the cost of the downtime the old system was causing, the internal route won easily.

In-house know-how

To achieve a total replacement in-house, I designed the new control panels



Image courtesy of Thyssenkrupp

Figure 1: The shot blasting machine throws steel shot at metal parts to remove the scale that clings to them as a result of the manufacturing process.



Image courtesy of Thyssenkrupp

Figure 2: The control panel was designed, assembled, and wired in-house, saving a great deal of money and keeping the know-how internal as well. Roughly 98% of the components, including the Productivity2000 PLC and eight DURApulse VFDs, along with many other essentials, were able to be obtained from just one source: AutomationDirect.

and our team fabricated and wired them in our shop (Figure 2). Before heading to the production floor, everything was shop-tested. The robots were also programmed by in-house team members with experience in that specialty. When everything checked out, the whole system was installed during a three-week shutdown.

Roughly 98% of the bill of materials came from AutomationDirect. Having encountered the brand at a previous job, I valued their readily available resources: free software, clear documentation, and ready-to-use CAD files that dropped straight into our engineering drawings. For a jack-of-all-trades rather than a dedicated integrator, this type of openness— along with competitive pricing—made them the default choice.

The hardware behind the rebuild

The new system is designed around three AutomationDirect Productivity2000 PLCs. Although this was a first exposure to the specific PLC family, out of the box it was one of the easiest platforms to get a handle on that I've used. That's due in part to the tag-based programming, which allowed creating useful tagnames as opposed to the classic PLC approach of assigning and tracking memory addresses. Tagnames made the program much easier to read and understand for whoever might need to work with it in the future. The PLC also came with a variety of built-in functions that were able to cover every task the old PLC was doing and then some. Nothing in the original program was lost in the swap.

The cell is physically spread out, so the primary controller sits in the main panel and communicates with a dedicated PLC in each of the two mag booths, and also remote I/O using P2-RS modules located at the mag booths, the dust collector, the cooling conveyor, and the robot interface (Figure 3). A C-more CM5 touchscreen is the operator interface. One small but practical change was moving that screen up to where the operators actually stand, rather than leaving it where the old one happened to sit.

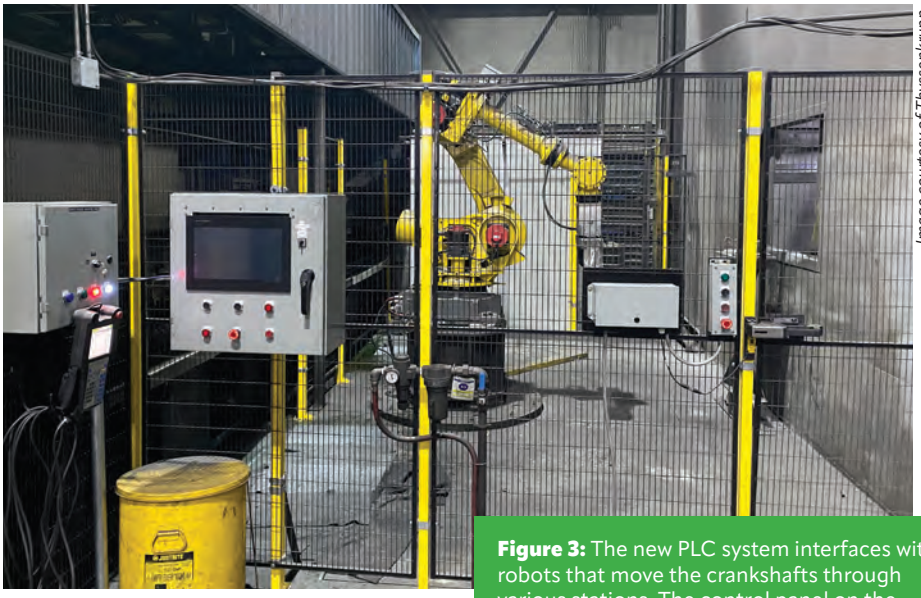


Image courtesy of Thyssenkrupp

Figure 3: The new PLC system interfaces with robots that move the crankshafts through various stations. The control panel on the far left holds the robot's "teach pendant" (a remote control and programming device), while the new panel just to the right of it houses the AutomationDirect C-more HMI, now in a far more useful location for the staff.

Improvements beyond just a replacement

Beyond replacing legacy components with modern and easy-to-use PLC and HMI systems, perhaps the biggest project improvement came from putting variable frequency drives (VFDs) on motors that never had them. The eight blast motors now run on DURApulse GS4 drives, which bring them up to speed smoothly instead of hitting them with full voltage on every start, and the operating speeds can be tailored as needed (Figure 4).

The two shot-moving augers and two elevators were also upgraded with DURApulse GS20 VFDs. Beyond reducing mechanical stress, controlled starts and effective speed control unexpectedly tightened operational cycle times, significantly improving overall efficiency.

Making things talk

The PLC and VFDs communicate over industry-standard EtherNet/IP. This was the first time our team had integrated this make/model of PLC and VFD, and it went really smoothly, thanks in part to the documentation and the setup videos on the website. An electronic data sheet (EDS) file is available for each type of VFD >>

Image courtesy of Thyssenkrupp



Figure 4: New AutomationDirect DURApulse drives allow for smoothly ramping startups and fine-tuning of the operational speed, which extends the life of both motors and the driven equipment. An unanticipated benefit was better cycle times for the whole process.

"The plan is to keep automating other parts of the line and, eventually, to pull everything together in a central control room."

and other intelligent devices, and this file is easily installed in the PLC software, which took most of the guesswork out of getting everything connected. No calls to tech support needed.

While the new PLC supports both explicit and implicit messaging, the decision was to go with implicit. Explicit messaging is request-and-response, meaning the controller asks for a piece of data when it needs it, which is fine for the occasional read or for configuration, but it carries more overhead per message. Implicit messaging, sometimes called I/O messaging, sets up a connection that exchanges data on a fixed schedule, cyclically and with very little overhead. For running a bank of drives in real time, implicit messaging is the better fit.

The cell also needed to communicate with the three industrial robots. This interface can be performed using traditional hardwired "handshake" signals, or it is possible to install an EtherNet/IP card into each robot. Rather than worry about installing new hardware in the robot controller, which comes with its own risks even though the robot programming is all done in-house anyway, hard-wire handshakes were the preferred option here.

Results, and what comes next

When the cell came back up after the shutdown, it worked beautifully. Nuisance alarms no longer ate into productivity, and the equipment was not being hammered with hard starts. The faster cycle time was the cherry on top of this complete system overhaul.

The most attractive thing about the new cell, however, was the cost. Our team will rely on outside services when necessary, but doing the work internally with AutomationDirect components saved the plant hundreds of thousands of dollars against the outside quotes. For an operation that's always looking to stretch its money and stay competitive, that's hard to argue with. The plan is to keep automating other parts of the line and, eventually, to pull everything together in a central control room. There are servo drives elsewhere in the plant that are candidates for the same treatment. The first project proved the approach works, and that a small in-house team with the right tools can take on work that used to go out the door.

Jerry Shuman *is a senior maintenance engineer at Thyssenkrupp's forging operation. He started his career on the production floor as a welder and worked his way up through manufacturing engineering, picking up electrical, hydraulic, and PLC fundamentals along the way and eventually moving into supervision. He later studied industrial technology at night while working as a reliability engineer, and spent time as an automation engineer in plastics injection molding and as an integrator serving steel manufacturers before stepping into his current role. He credits a series of good mentors for much of what he's learned.*

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Automation Upgrades Optimize the Harvest



An automation and equipment upgrade at this potato processing plant replaced decades-old controls to boost throughput and provide simplified operation, while creating a scalable foundation for more reliable production and future growth.

BY DOUG HALLER, ASPEN PRODUCE, LLC

A potato processing facility may not look like much on the surface, just like the tuberous vegetable itself. But dig a little deeper, so to speak, and one will discover an array of conveyor belts, elevators and other equipment operated with motors, sensors, and other automation devices that must coordinate in exactly the right way to keep production rolling along.

In southern Colorado at Aspen Produce — a grower, packager, and shipper of potatoes — our team recently undertook a long overdue automation upgrade and modernization. Ownership recognized a need to improve throughput (measured in pounds-per-hour), replace the plant's aging equipment, and provide automation to improve performance and support future growth. The project would need to be carefully scheduled to avoid impacting peak harvesting time periods, and we felt the best plan for success was to perform the work internally using our own staff.

Outgrowing the old lineup

The site's existing controls had been in service for roughly 20 years, with individual disconnects, starters, and control panels scattered across a long wall (Figure 1). As is typical with many industrial facilities, the installation evolved sporadically over the years. This arrangement had done its job, but the sorting and sizing equipment was reaching end-of-life, and operational control capabilities were limited, so production had already reached a ceiling.

As integration and controls manager, with years of experience as an electrical contractor and decades working in industry, I was excited to take on the electrical and controls aspect of this project. The mechanical side of the job, including new equipment and revised layouts, had already been specified by another team, which simplified the instrumentation and controls (I&C) planning considerably. Because the new configuration was somewhat different than the existing one, we needed to determine the overall automatic sequence, and how best to provide local control options.

When the upgrade was proposed, an initial question was whether it made sense to repurpose the existing electronics rather than replace them outright. Since every piece of mechanical equipment on the line was new, and the existing automation contained legacy elements, it simply made sense to develop new controls — providing a clean break that would make the upfront programming, future expansions, and any troubleshooting far easier.

Sizing up a single panel

With the decision to automate using a clean-sheet approach, we knew the old wall would become free space as existing components were cleared out. Rather than spreading control across many small enclosures as with the old system, we needed a single, centralized panel housing a new programmable logic controller (PLC) and input/output (I/O), along with the electrical motor controls. The human-machine interface (HMI) touchscreen display would be installed in three separate locations convenient for the operators.

Consolidating controls into just one or a few panels only works if the enclosures can comfortably hold everything without turning into a

Figure 1: This picture from before the upgrade shows the plant's original motor controls, including dozens of individual disconnects and starters mounted along a wall. The layout had worked for two decades but left little room to improve throughput or add centralized monitoring.



Image courtesy of Aspen Produce



Images courtesy of Aspen Produce

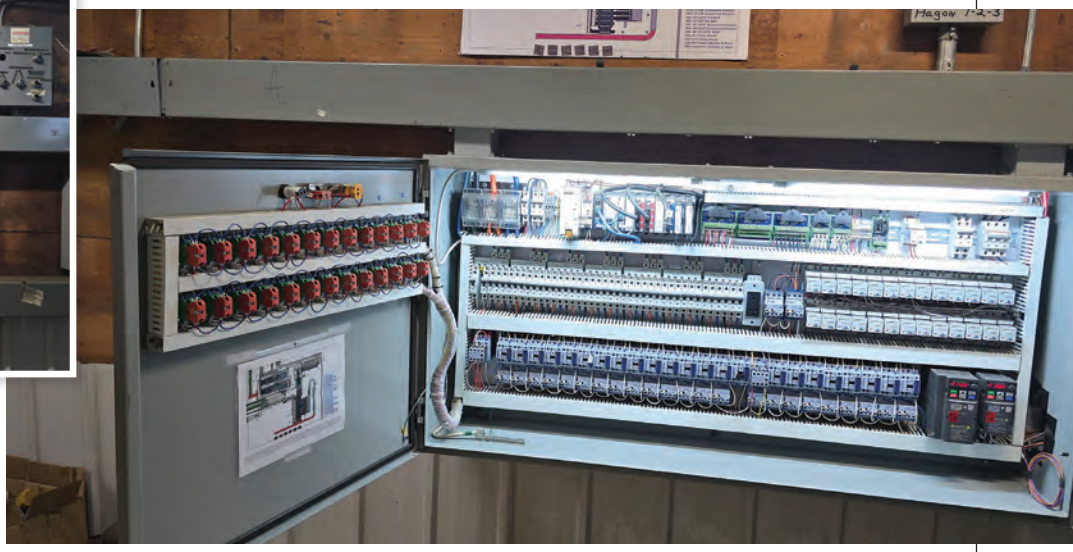


Figure 2: This photo shows our design results; a fully-loaded but still easily serviceable control enclosure with the BRX PLC and I/O, power distribution, 26 contactors, 2 DURAPulseVFDs, many hand/off/auto switches, a StrideLinx switch, and other components, all sourced almost exclusively from AutomationDirect.

wiring rat's nest, so panel layout and component selection had to be worked out together, not separately. Control for nearly 30 motors is a lot to fit into one enclosure, especially with a requirement for dedicated hardwired hand/off/auto switches in the panel door, but we were able to achieve this feat due to the compact size of modern automation components. (Figure 2).

The site has already had a positive experience with AutomationDirect products, with about 12 human-machine interfaces and 10 PLCs throughout the plant, all communicating with each other. This made it natural to select virtually all control panel components from this supplier. A BRX PLC and I/O modules, combined with ZIPLink pre-wired cables and modules, provided an exceptionally compact way to install and connect the PLC. Furthermore, this PLC offers native Modbus RTU communications for interfacing with variable frequency drives (VFDs), and it can send JSON data packets to in-house software applications (more on this later).

Inside a wide double-door enclosure, 26 motor starters and two DURAPulse GS20 VFDs are neatly organized in a single row. AutomationDirect's website speeds up the design process because selecting a starter or contactor on the site automatically identifies the accessories and add-ons the component actually needs, and all the supporting documents and drawings are easily downloaded.

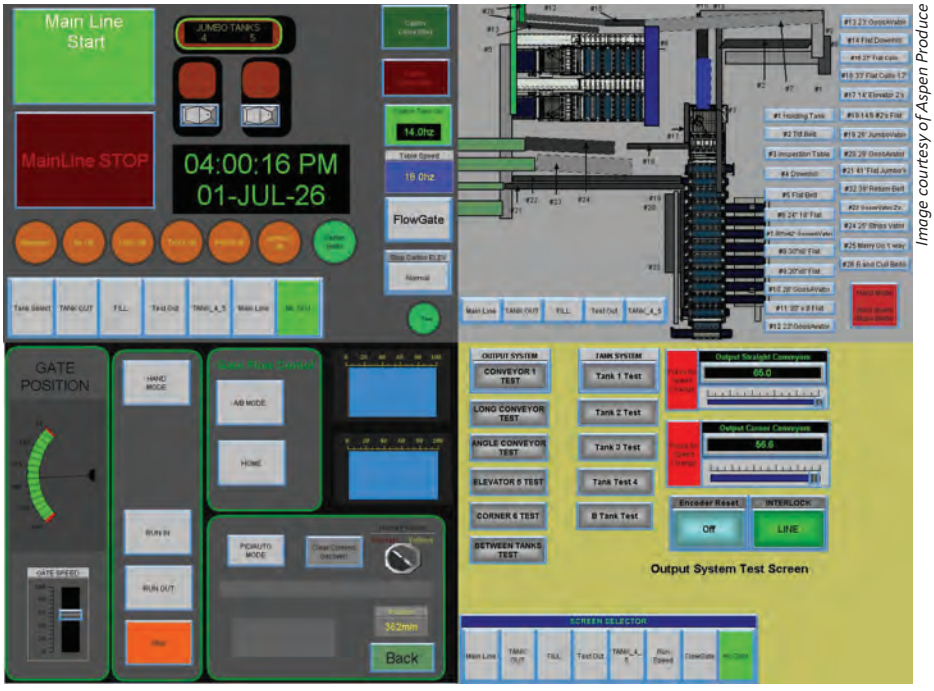


Image courtesy of Aspen Produce

To save even more space — and improve appearance and serviceability — we used a busbar power distribution system. Busbars cost a bit more than standard wiring, but installation labor savings help justify the cost, and other benefits provide a better final product. The control wiring installation followed a similar philosophy, with jumpers cut in batches and terminated using ferrules for best consistency.

Figure 3: Three AutomationDirect C-more HMIs are located strategically throughout the operation to provide operators with main line start/stop, tank and gate controls, a dedicated output-system test screen, and other visualization and control options. An equipment layout/list screen provides a helpful overview for the operators.

Cascading a cleaner start

Centralizing control didn't mean giving up local, hands-on operation. A series of hand/off/auto selector switches operating interposing relays ensures that operators and maintenance personnel have an easy and direct way to run individual equipment for testing, repair, and cleanout. This is a typical need for many conveyance systems, including ours. >>

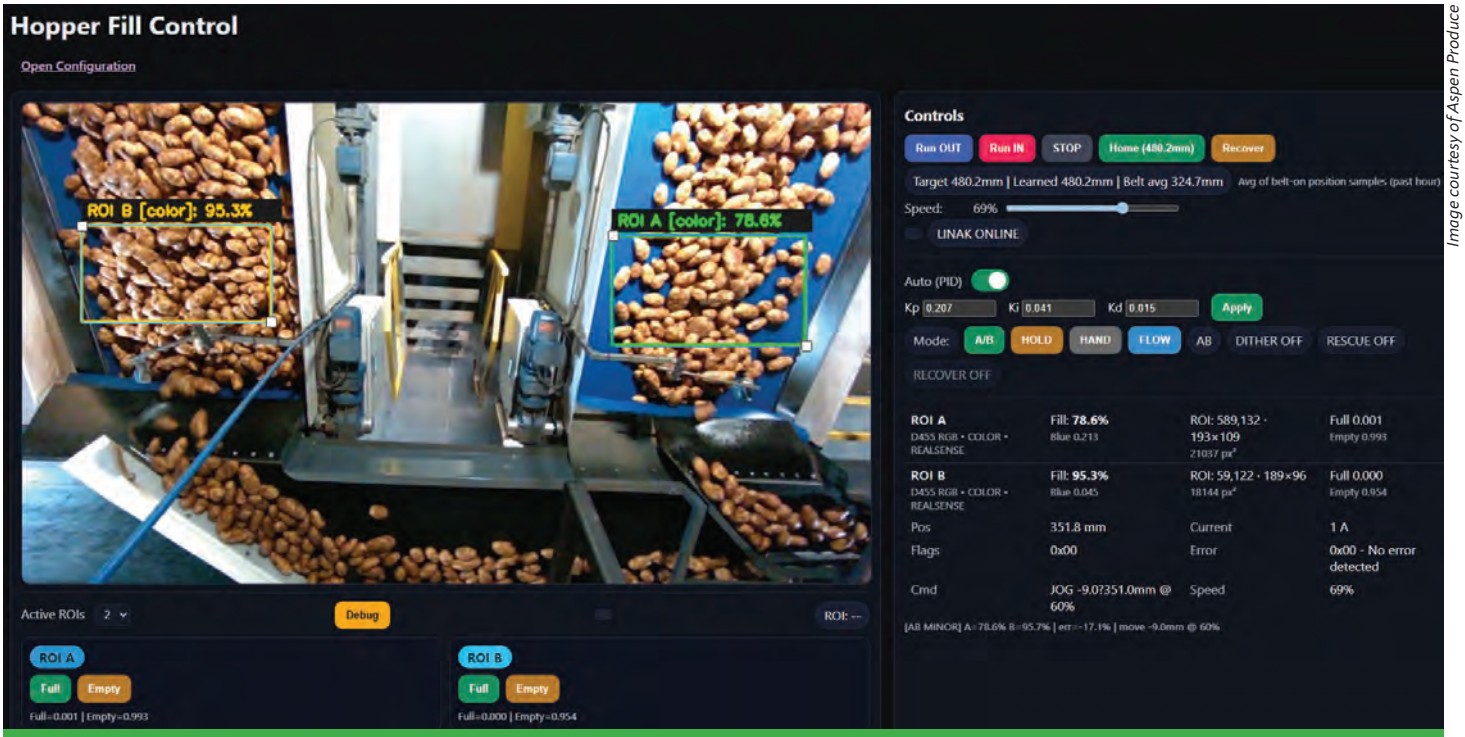


Image courtesy of Aspen Produce

Figure 4: In addition to traditional PLC control functionality, the BRX incorporates native JSON communications capabilities and many other protocols, making it easy to interface with in-house developed Python applications, so the team can incorporate advanced vision-based feed rate control strategies.

However, a significant advantage of PLC control is creating more sophisticated and capable automated operation, along with improving visibility. In this case, the PLC-based system provides a cascaded startup sequence from the front of the conveyor system to the back, which is more efficient and gentler on the mechanical equipment as compared to the old, hardwired logic.

The HMI delivers a complete overview of operations and empowers operators to make configuration changes (Figure 3). The native cloud-accessible capability of the HMIs is not used by Aspen, but they can be remotely accessed via the site's own servers. The programming software is free, and the training videos made it easy to get up to speed on features the plant hadn't used before.

Both VFDs connect with the PLC using the Modbus RTU serial protocol rather than hardwired I/O, so the PLC can command the speed and read back the status. The site uses VFDs to control holding tanks, inspection tables, and some conveyors, providing the ability to optimize throughput based on potato size and quality.

Another improvement was adding PLC-monitored proximity switches to the undriven tail shafts of conveyors so that belt slippage or breaks are easily detected. Thousands of feet of belting run throughout the building, much of it near the ceiling to save space, but making it hard to access and inspect. Therefore, detecting problems early and remotely, and then pointing maintenance personnel to the specific trouble location, is extremely important to avoid creating mounds of potatoes after a failure.

The automation platform handles much more than basic motor control; it is effectively a gateway to machine learning (ML) and artificial intelligence (AI). A vision system monitors the potatoes entering two conveyor belts, evaluating the effective infeed load using a Python application running on an Nvidia Jetson embedded computing platform, which in turn communicates with the PLC using JSON packets over Ethernet. The PLC uses this information to adjust potato feed rates to the optimal level, and the vision application uses ML to improve with every production run. This direct connectivity provides the plant with a streamlined way to integrate advanced control, without needing a separate data acquisition layer (Figure 4).

The proof is in the potatoes

What used to be a wall of individual and hardwired electrical devices is now consolidated into a single enclosure, with a PLC coordinating a cascaded startup, and a separately-located HMI delivering a clear supervisory interface. The plant runs more predictably with increased throughput, and maintenance personnel benefit from many easy-to-use testing and troubleshooting capabilities. Just as important, the site can now enhance control strategies as needed and scale up the automation as production requirements expand. Based on the success of this system, two more similar control panels have already been added to optimize other plant operations.

Doug Haller *is the integration and controls manager at Aspen Produce, a grower, packager, and shipper of potatoes in southern Colorado. Before joining Aspen Produce, he spent several years with an electrical contractor, and he has decades of additional experience working as an industrial process specialist. Haller led the design, build, and programming of the facility's rebuilt sorting-line control panel. He also gives credit to his father, an aerospace engineer, as being a great teacher and inspiration.*

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These relays feature a high accuracy adjustable current dial for precise motor protection, along with visible trip indication for quick status checks. A built in manual trip mechanism and selectable reset operation offer added flexibility during commissioning and maintenance. The finger safe terminal design improves safety during installation and inspection, while isolated N.O./N.C. auxiliary contacts support integration into a wide variety of control circuits.

The TK E02 series covers a broad range of low current applications with adjustment ranges from 0.1 to 25 amps, making it ideal for use with compatible Fuji SC E contactors. Its compact footprint and optional base unit allow both direct and separate DIN rail mounting, simplifying panel layout and system design.

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ifm efector PQ Series Digital Pressure Transmitters

AutomationDirect has added ifm efector PQ series digital pressure transmitters that combine IO-Link communication, a multi-mode TFT display, and versatile output options in a compact, rugged housing ideal for space-constrained installations. Available with -14.5 to 14.5 psig and -14.5 to 145 psig ranges, they support vacuum, low-pressure, and standard compressed air or nitrogen applications. The 1-inch multi-color TFT LCD provides clear process visualization, while six selectable pressure units simplify setup for global use.

Output options include NPN/PNP switching, current, voltage, and IO-Link for seamless integration with a wide range of control systems. The IP40 thermoplastic housing features a lockable keypad to help prevent unauthorized adjustments. Wall, panel, and DIN-rail brackets support flexible mounting options.

Learn more: *https://www.automationdirect.com/digital-pressure-switches*



Wenglor weFlux2 Series Flow Sensors

AutomationDirect has added Wenglor weFlux2 insertion-style flow sensors which measure flow velocity and temperature using a single probe for closed-pipe systems. By eliminating the need for a separate temperature sensor, they reduce installation and wiring complexity, as well as overall system cost. Operating on the calorimetric measuring principle, they detect changes in heat dissipation within the flowing medium to deliver accurate, reliable readings regardless of mounting orientation or flow direction.

They measure flow velocities from 10 to 400 cm/s (0.33 to 13.12 ft/s) and offer two configurable outputs for switch, analog, or IO-Link operation, depending on the model. Models are available with 75, 100, or 200 mm probe lengths and feature laser-welded 316L stainless steel housings with IP68/IP69K protection to withstand harsh washdown environments. The IO-Link versions also include built-in parameter storage to simplify commissioning, device replacement, and integration into automation systems.

Learn more: *www.automationdirect.com/thermal-flow-sensors*

NEW PRODUCTS



AutomationDirect P1 UX Universal Field IO Bus Coupler

AutomationDirect now offers the P1-UX Universal Bus Coupler which allows low-cost Productivity1000 PLC I/O to be used as high-performance universal field I/O across a wide variety of PLC platforms, including third-party and mixed-control environments. The P1-UX makes it easy to standardize on Productivity1000 I/O while maintaining complete freedom of controller choice. This approach helps reduce overall system cost while improving design consistency and simplifying expansion across applications.

The P1-UX module supports both Modbus TCP and EtherNet/IP, providing broad compatibility with common industrial Ethernet networks without requiring different hardware versions. A built-in webserver allows fast, intuitive configuration from any standard web browser, eliminating the need for separate software and streamlining setup, commissioning, and maintenance.

The P1-UX works with a wide range of Productivity1000 I/O modules, offering scalable options for discrete, analog, and specialty control needs. With its combination of flexible protocol support, simple configuration, and exceptional value, the P1-UX is an ideal solution for expanding or standardizing remote I/O in modern automation systems.

Learn more: *www.automationdirect.com/fieldIO*



Leuze Large Rectangular Photoelectric Sensors

AutomationDirect has added Leuze 49C series large rectangular photoelectric sensors that are designed for reliable object detection in harsh conditions with detection ranges up to 120m. This series is available in diffuse with background suppression, polarized retroreflective, and through-beam configurations, and delivers robust performance with optimized geometry, clearly visible status indicators, and straightforward alignment and wiring. Their IP67 rating and options such as integrated optics heating make them ideal for outdoor or condensation-prone environments. With complete overload protection, 49C sensors offer AC or DC operating voltages, M12 quick-disconnect terminations (cable sold separately) for quick and easy connections, as well as pigtail and terminal block models.

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AutomationDirect now offers Murrplastik MP35 and MP45 series drag chains that are engineered to protect and organize cables and hoses in robotic, packaging, and other dynamic motion applications. Both series feature EVOSILENCE® technology, which reduces operating noise by up to 10 dB(A), and a SOFT-STOP system that minimizes stress and wear during operation. The MP35 series accommodates cables and hoses up to 30mm (1.18 in.) in diameter, while the MP45 series supports larger cable bundles up to 40mm (1.57 in.). Both offer convenient snap-open access from the inside or outside bend radius for quick cable installation and maintenance without removing the chain from service. Constructed from durable polyamide with integrated strain relief end brackets, modular lengths, and optional separators for cable organization, the MP35 and MP45 series drag chains deliver longer cable life, improved safety, and reduced maintenance in high-cycle industrial environments.

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AutomationDirect now offers Optris Xi 410 LT series infrared thermal cameras that combine the functionality of a thermal imaging camera and an infrared pyrometer in a compact, fixed-mount solution. Unlike single-point infrared sensors, the Xi 410 LT monitors an entire field of view, allowing users to visualize heat distribution, identify hot spots, and capture multiple temperature measurements from a single device.

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Xi 410 LT accessories include a stackable process interface module (up to three units) that provides additional analog and discrete I/O along with three alarm relay outputs. The Modbus TCP interface kit enables communication with PLCs, SCADA systems, and network devices. An air purge assembly keeps the lens clean in harsh industrial environments, while the adjustable 2-axis mounting bracket simplifies camera positioning. Emissivity labels improve measurement accuracy on reflective surfaces. Free Optris PIX Connect software provides full radiometric analysis, video and snapshot recording, camera configuration, a built-in web server, and configurable alarm output programming.

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