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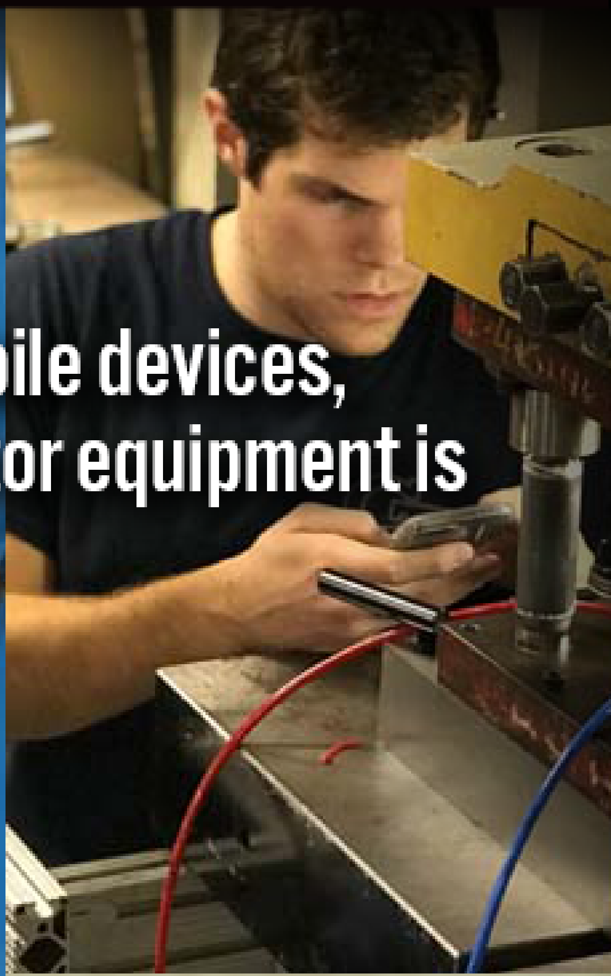
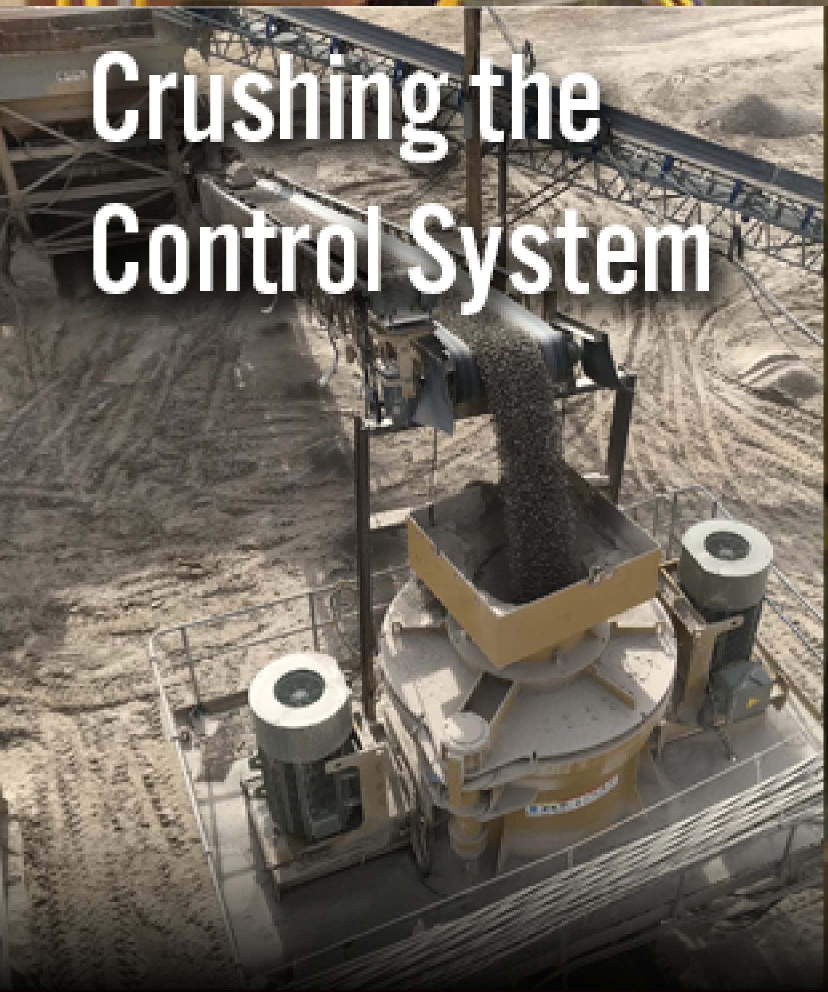
Your guide to practical products, technologies and applications

Mobile is the New Normal

Most plant floor workers already carry mobile devices, so using them to access, control and monitor equipment is a natural next step.



Crushing the Control System

Upgrading to a modern control system platform, with the help of a local system integrator, transforms a rock crushing plant from manual to fully automatic operation.

www.AutomationNOTEBOOK.com | Digital Issue 42

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Monday - Friday

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For those who prefer to speak with us in person, please call 1-800-633-0405 x1845. Thanks for your interest, and we look forward to hearing from you.

I BINGED STRANGER THINGS

When you think of Georgia, what comes to mind? Peaches? Vidalia onions? The Atlanta Falcons? For sure AutomationDirect's in there, but what about Stranger Things? I don't mean things that are stranger than AutomationDirect, I'm talking about the popular Netflix series that is filmed primarily in and around Atlanta, GA. At first, I had no interest in this series but when it pulled my son away from his YouTube channels, something that no other show managed to do, I decided to take a quick glance. That quick glance led to a binge watching of all three seasons and I'm now anxiously awaiting the next installment. You see, I'm a child of the 80s and this show captures that era perfectly. With the music, the cars, the clothes, even the retro style Burger King wrappers, this show had me as a fan very quickly. So much so, that I recently went on a self-made "tour" of some of their film sets around town. On my first stop (Hawkins Middle School), it became very apparent that I wasn't the only one doing this and it amazed me how a show's fans can turn an ordinary location into a busy tourist attraction. Just like with our customers, the fans of the show are its lifeblood, allowing it to thrive and keeping it alive. At AutomationDirect, we know we wouldn't be here without all of you and we're so grateful for every one of our customers. We'll always keep your best interest in mind and hope that you'll continue to trust us with your automation needs.

This issue of NOTEBOOK is filled with informative content such as our PLC Speaking section, which demonstrates how FIFO queues are used in package handling operations. We also have a great Cover Story on the growing popularity of using mobile apps for machine interfacing. The User Solution shows how CTC Crushing improved their rock crushing operation with Productivity PLCs, and our Student Spotlight focuses on Eastern Washington University students and their automotive semi-active suspension system. In the Tech Thread section, we take a closer look at the differences between traditional and hosted VPNs, the New Product Focus portion provides information on our cut-to-length cable additions and the STRIDE Pocket Portal cloud data logging solution, and the What's New? section highlights some of our many other informative content pieces. As always, the Break Room is stocked with fun brainteasers to test your knowledge, so see how many puzzles you can solve. Don't forget to check out our library site (*library.automationdirect.com*) for more amazing content and visit our store (*www.automationdirect.com*) to see all our current and new product offerings.

Control and Signal Cable in Specified Cut Lengths

Control and signal cable from AutomationDirect is available in customer specified one-foot increment lengths in sizes from 22 AWG to 16 AWG with 2, 3 and 4 conductors, shielded and unshielded. The cable carries both UL and CSA approvals.

Individual conductors are stranded tinned copper with PVC insulation in black, red, white and green color codes for easy identification. Shielded cable versions include an overall aluminum mylar foil tape with a tinned copper drain wire for maximum effectiveness against external electrical noise. The flexible PVC cable outer jacket color is industry standard chrome gray.

With a 300-volt rating, these cables are ideal for low voltage control of small devices such as solenoids, alarm horns, signaling lights and small motors; and for connecting limit switches, temperature, pressure, proximity and other sensor types.

Starting at $0.20 per foot, control and signal cable is available in cut-to-length 1-foot increments with a 30-foot minimum cut length.

Cut-to-length cable eliminates waste and lowers cost (only as much cable as required is purchased). There are no cut charges (and no shipping charges on orders over $49). Cable is cut to length at AutomationDirect's own UL Certified respooling facility and is available for same day shipping if ordered by 6:00pm ET.

Go here to learn more about Control and Signal Cable

**Prices as of August 2019.
Check www.automationdirect.com for most current prices.*

STRIDE Pocket Portal IoT Bridge Coud Data Logger with IO

The "Internet of Things" for industrial applications (IIoT) allows greater visibility and access to machine and process data through cloud computing. The STRIDE Pocket Portal is a low-cost ($120.00) industrial wireless IoT end-to-end cloud data logger that connects industrial equipment and sensors to the cloud.

The Pocket Portal has an RS-485 communications port, input/output port, browser interface, and provides limited control with Modbus RTU write capability (up to 115.2k baud) and 3VDC discrete output logic. Unmonitored devices can be IoT connected and become monitored quickly with Modbus RTU, 4 digital and 2 analog inputs. A Modbus device and up to four discrete outputs can be remotely controlled using one IoT bridge and Pocket Portal mobile app.

The Pocket Portal IoT solution from AutomationDirect requires a Wi-Fi internet connection and a monthly data subscription. Data subscription plans start at $8 per month for 500K data samples with email notifications. Up to 6 months of data storage with up to 15M data points available with active subscription. 30 day free trial is also provided.

Go here to learn more about Pocket Portal

What is the Difference Between Traditional and Hosted VPNs?

When connecting automation components to the IIoT, consider the capabilities and advantages of these two main methods of VPN-based remote access.

By Jonathan Griffith, Product Manager, Industrial Communications & Power Supplies at AutomationDirect
This article originally appeared in Machine Design, March 2019.

Connecting programmable logic controllers (PLCs), human machine interfaces (HMIs) and other automation system components to the industrial internet of things (IIoT) for remote access is important for many manufacturing plants, and to the machine builders providing equipment and services to these plants. In the past, remote access was often accomplished via a router without a virtual private network (VPN), but these router-only connections to the Internet should not be implemented today due to security risks.

Instead, a VPN should be used, as it is one of the key elements to a defense-in-depth strategy. However, implementing a secure IIoT connection to automation system components via a VPN often presents cost, technical and resource allocation issues. The two solutions presented in this article address these challenges, but in different ways. Each solution has its own advantages and design considerations as noted in the Table. The two options are hosted VPN and traditional VPN.

IIoT Connection Considerations, Router with VPN

	Hosted VPN	Traditional VPN
External Cost		
Initial	Medium	High
Sustaining	Bandwidth dependent	Low
Internal Support Cost	Low	High
Required Technical Expertise	Low	High
Changes to Existing Firewall	Not Required	Required
Security Risk	Low	Low
Data Dashboards	Available through subscription	Typically not available
Data Storage & Access	Available through subscription	Typically not available

The choice to use a hosted VPN versus a traditional VPN depends on three main factors:

- Will all the IIoT connection needs fall under similar IT conditions, and will each site be able to use the same router configurations?
- Is IT expertise available to support a traditional VPN solution?
- Is high bandwidth required for this solution?

If the answer to any of these three questions is "No", then the best option is likely the hosted VPN solution. If all three questions are answered "Yes", then the preferred option is likely the traditional VPN solution.

Hosted VPN Solution

A hosted VPN solution provides secure IIoT connectivity with simple setup and network configuration. These solutions usually include a local VPN router, a cloud-hosted VPN server and a remote VPN client. Automation system components are connected locally to the VPN router, which connects to the cloud server. The VPN client connects by laptop or PC to the cloud, and ultimately to the local automation system components (Figure 1).

To accomplish this, the local VPN router makes a VPN connection to the cloud server immediately upon startup, but the VPN client only connects upon a verified request from the remote user. Once both connections have been made, all data passing through this VPN tunnel is secure

Communication is initiated by the local router to the cloud-based server via an outbound connection through standard ports that are typically open, such as HTTPS. This usually requires no changes to the corporate IT firewall, thus satisfying IT security concerns.

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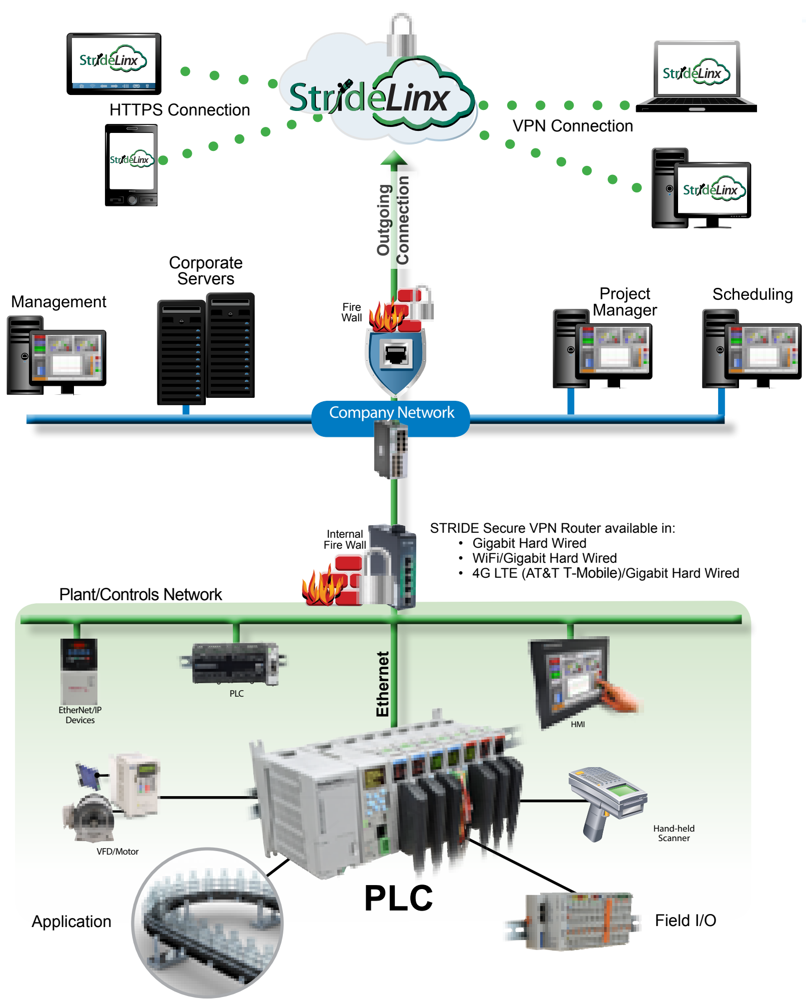

Figure 1: Hosted VPN Diagram. AutomationDirect's StrideLinx Secure hosted VPN solution for IIoT connectivity has no monthly fees if data use is under 5 GB a month.

Traditional VPN solutions require IT involvement and oversight in order to open inbound firewall ports, which often poses problems.

Hosted VPN solutions only require simple router configuration because the router (*Figure 2*) is connected to a predefined cloud server. This allows the hosted VPN vendor to deliver the router preconfigured, so the user only needs to add basic network information. The router's default firewall settings keep the plant floor network separate from the corporate network.

The VPN router should include Wi-Fi and 4G LTE connectivity options, in addition to a wired LAN option. The Wi-Fi option allows the router to operate in access point or client mode. With access point mode, wireless devices connected to the router are on the LAN network, allowing plant personnel to access the control system local area network (LAN) wirelessly, rather than opening the panel to access the physical LAN connection ports. With the 4G LTE option, access can be provided from remote locations without internet access, or from locations that will not provide access to their corporate network.

Figure 2: VPN cabinet. By only providing the functionality needed for IIoT connectivity, this AutomationDirect StrideLinx VPN router, installed on the far right of the DIN rail and connected to the PLC, simplifies implementation and use.

Security risk is minimal with this solution because the remote client connection to the cloud server uses the robust encryption standard SSL/TLS. The required TLS key exchange, crucial for security, is done in accordance with industry standard 2048-bit RSA with SHA-256.

To further enhance security, some vendors provide advanced user management, event logging and two-factor authentication. This method of authentication requires a second time-based password generated at login, providing an extra level of security.

A typical hosted VPN solution has a free monthly bandwidth allocation for basic operation, and then offers a premium plan for additional bandwidth. Normal troubleshooting and programming needs normally fall under the free data allocation, but extensive data monitoring or video surveillance may require additional bandwidth.

Hosted VPN Requirements

With the recent rash of data breaches, it's important to have a high level of trust in the selected hosted VPN vendor as it will be responsible for

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securely storing data and making it available to only those who need it. This is of course a concern for any IIoT implementation, and some hosted VPN vendors have much better security measures in place than others.

Monthly costs incurred for exceeding the free data bandwidth usage must also be considered, particularly as those costs are zero for a traditional VPN solution. Again, these costs vary widely from one vendor to the next, and should be evaluated closely. IT support is not needed because the solution is simple to implement and maintain, with acceptable security built in.

With this solution there are some limits in terms of advanced routing features, although these features aren't required in most application. Complex IIoT implementations such as machine-to-machine networking, advanced Network Address Translation (NAT) configuration and access control lists may require a traditional VPN implementation.

Specific features offered by the router vendor can enhance design flexibility and value, easing design considerations. Some of the leading features include IIoT data logging, widgets for configuring remote access dashboards, a web-based platform for router configuration, and a digital input for enabling/disabling remote access.

IIoT data logging provides collection, storage and display of data via a cloud-based platform, allowing storage of and access to a virtually unlimited amount of data, while only requiring payment for the required capacity. This makes it feasible to start with a minimal amount of storage, and then increase if needed by paying more each month. The vendor's cloud-based data logging usually requires an additional license or subscription to collect and store the data in the cloud platform.

A traditional VPN solution requires a third-party HMI, either PC-based or embedded (*Figure 3*), to provide data logging and widgets for configur-ing remote access screens. Many hosted VPNs do not require an HMI because they provide their own graphical interface capabilities. With these solutions, users can configure dashboards using widgets for remote access via their PC or mobile device (*Figure 4*). Users can also configure alerts and notifications to indicate when parameters fall outside a predefined range. Creating remote access viewing screens can be cumbersome if this feature is not provided, so this must be taken into account when evaluating competing hosted VPN solutions.

Figure 3: C-more. When traditional VPNs are used, a local HMI, such as this AutomationDirect C-more panel, is often part of the solution.

Some hosted VPN solution vendors provide quick and easy configuration of the VPN router via a web-based platform. Ideally, this will only require account registration, configuration and downloading of router settings, and installation of a secure client on a PC. A web-based platform is better than PC-based configuration because updates can be made without having to reinstall a new version of the configuration software on a PC, particularly important when new

Figure 4: Dashboard on PC. This AutomationDirect StrideLinx Secure Remote Access dashboard is easy to configure using provided widgets.

continued >>

features are added on a regular basis.

For enhanced safety, the VPN router should have a discrete input to locally enable or disable communications via a manual switch to prevent remote control of a machine during maintenance periods.

Traditional VPN Solution

This solution uses a local VPN router to connect through the internet, with a secure VPN tunnel to a second remote VPN router, or to a software client, which is typically installed on a PC (*Figure 5*). After these connections are made, remote users can access automation components connected to the local router through the VPN tunnel.

There is no cloud server between the two devices with either method of connection: VPN router to VPN router, or VPN router to software client. This traditional VPN solution may be needed when large amounts of data must be continuously exchanged between the local and remote sites, as with remote viewing of local video.

This solution was the only method of secure two-way access prior to the fairly recent introduction of cloud-based remote access solutions via a hosted VPN around 2012, so it's widely used. But it is complex, and can therefore be costly in terms of internal resources required for support, both at the local and the remote site.

Traditional VPN Requirements

The IT team must have the capability and willingness to support this solution at both the local and remote sites for each installation. If this solution is being implemented by an original equipment manufacturer (OEM) machine builder, for example, the OEM must consider every customer site, and make sure all of its customers can provide the required high level of IT support. In some cases, the OEM may have to customize its remote access solution for each customer, greatly adding to implementation and support costs.

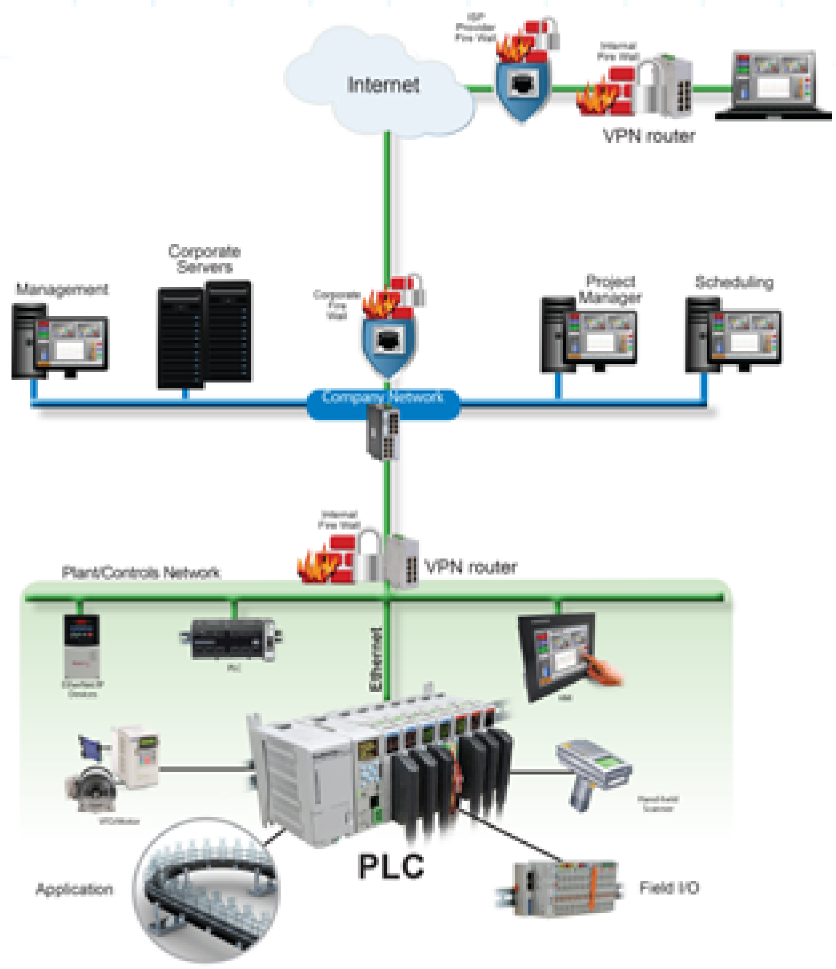

Figure 5: Traditional VPN Diagram. With this traditional VPN solution, two routers are commonly used, each requiring IT support both locally and remotely.

Depending on the networking requirements, this solution may have approximately the same initial costs as a hosted VPN solution if a router and VPN client implementation is chosen. For applications such as machine-to-machine where two routers are required, the traditional VPN solution has a more expensive initial cost.

IT resources are required to configure the connection, adding to design and implementation costs. Larger companies may have a dedicated IT staff to provide this support, but most smaller companies will not, requiring outsourcing of required IT resources. Although ongoing external costs are lower because there are no monthly cloud service fees, internal costs are higher due to the need for IT support.

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For many companies, a security concern is created because IT must open an inbound VPN port on the firewall. This is done to provide full remote control and monitoring by creating a single IIoT network joining local and remote users. This raises a security concern as the inbound VPN port must constantly be protected with a high level of access control. In addition, ongoing security vigilance is needed to ensure router and VPN protocols remain up to date. Other technical considerations must also be addressed including:

- Configuring firewalls
- Addressing subnet conflicts across sites with similar network design
- Controlling user management and access
- Implementing event logging
- Creating and managing security certificates
- Applying advanced networking knowledge
- Configuring clients at each connection point

Even with these challenges, a tradition VPN is preferred if the required IT staff is available and the application requires high data bandwidth, or if there is a requirement to not rely on a vendor for a hosted VPN solution.

Using a Hosted VPN

In our first example, an OEM's machine does not require remote video monitoring. Local operator interface is provided by an embedded HMI with limited data logging and storage functionality.

The OEM machine builder needs secure remote access, and an easy to configure data dashboard for remote monitoring. VPN access is required to provide remote troubleshooting, debugging and programming of the machine's PLC and HMI. Both the OEM and its customer require monitoring of the machine's most important operating parameters on mobile device dashboards.

The OEM machine builder doesn't have an IT department, just one part-time person who set up their internal network. Their automation staff consists of one control systems professional who is an expert when it comes to programming PLCs and HMIs to automate their machines, but is not very familiar with IT, VPN and router technology. Most of the OEM's customers are not willing or able to reconfigure their firewall, eliminating the traditional VPN option.

In this case, a hosted VPN solution is the best choice because it will satisfy the OEM and customer requirements, and it can be implemented without the assistance of IT staff.

Data logging is provided in the cloud, so the local HMI's limited data storage capability is not an issue. Widgets can be used by the machine builder to create dashboard screens for viewing on remote devices by many different users. When full remote control and monitoring is required via the IIoT, it can be provided by installing a lightweight software client on a PC, which can connect to the cloud from any location worldwide.

Using a Traditional VPN

In this second example, the OEM sells very large and complex printing presses with thousands of automation system I/O points, and its customers require the OEM to provide support of the machine, including uptime and throughput guarantees. The OEM needs to remotely monitor and support its presses worldwide to make sure guarantees to customers are met.

The OEM has considerable IT expertise and is capable of implementing a traditional VPN, and each of its customers is willing to allow the required firewall modifications.

Each press also has multiple video cameras installed for remote viewing, a necessity for solving some of the more complex troubleshooting issues. Each printing press has a full-featured PC-based HMI installed to provide local viewing and data storage, with high-speed remote access to the HMI and its stored data required at all times. Therefore, large amounts of operating data must be continuously transmitted to the remote corporate control center.

A traditional VPN is the right solution in this application because of the significant amount of data exchange required, which could be cost prohibitive for a hosted VPN, and because the right IT resources are available to support the solution at the control center and at each site.

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Decisions

When implementing an IIoT solution for remote access, a VPN is necessary to provide the required security. Older solutions without a VPN simply don't provide the needed level of protection from intrusion.

Once the decision has been made to use a VPN for remote IIoT access, the two main types of solutions are a hosted VPN and a traditional VPN. The hosted VPN is the more modern solution and works well in most instances. The traditional VPN provides the utmost in performance for implementations requiring very high bandwidth, but is more complex to design, install and support.

Author Bio

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PLC Package Handling

PLCs play a major role when it comes to material or package handling operations. Conveyors, motors, drives, object detection sensors and of course controllers are used quite often when it comes to delivering your suitcase to the right airplane or getting the laptop you ordered to the right delivery truck. But how would you go about coding the PLC for a package handling application? Fortunately, I have first-hand experience with these kinds of systems and I'll show you one way to go about it.

To track a package as it moves along a conveyor, you first need to let the PLC know when and how far the conveyor is moving. This can be done by mounting a rotary encoder along the conveyor belt. Rotary encoders…well…rotate…and will emit a digital pulse for a set amount of rotation. For example, the TRD-MX1000AD rotary encoder will supply 1,000 pulses for every complete revolution. If one revolution equals 1 ft of travel, then the amount of distance travelled per pulse seen by the controller is .012 inch ((1ft. or 12 inches)/1000 pulses). The ppr or pulses-per-revolution of the encoder will determine how accurate the positioning or tracking can be.

One thing to remember with encoder signals is that the speed of the conveyor belt will determine if high-speed input capability is required. Using the example encoder above, if the conveyor at our facility is run at a speed of 120 ft/m, with 1,000 pulses coming into the PLC every 12 inches, that would be 2,000 pulses per second (trust me it works out :)). The PLC might not be able to keep up with these encoder pulses during its normal scan time and therefore would require high-speed input functionality to be sure no pulses were missed. Missed pulses mean the tracking will be off, and if it's off enough, that could mean a diverter missing a suitcase on its way to the plane or crushing the laptop you just ordered.

For our example, we don't need a high level of accuracy so for simplicity we are going to use an encoder that provides 1 pulse per every inch of travel. We'll also need a photoeye, so the PLC knows when a box is present at the start of the conveyor line. We'll be controlling three diverters and for a little extra, we'll add a selector switch to determine which chute the package should divert to depending on the day of the week. Once we have all that installed and wired up, we are ready to code.

Getting a handle on package handling

When it comes to programming any device, there are many methods and techniques possible. I am going to use ladder logic for this package handling application. I will utilize a shift register, a FIFO queue, a counter, and a few other elements. Oh, and I will be doing all of this with the FREE Do-more Designer PLC software. This software is very powerful, and the convenient simulator will allow me to test the logic operation and hopefully prove this actually works.

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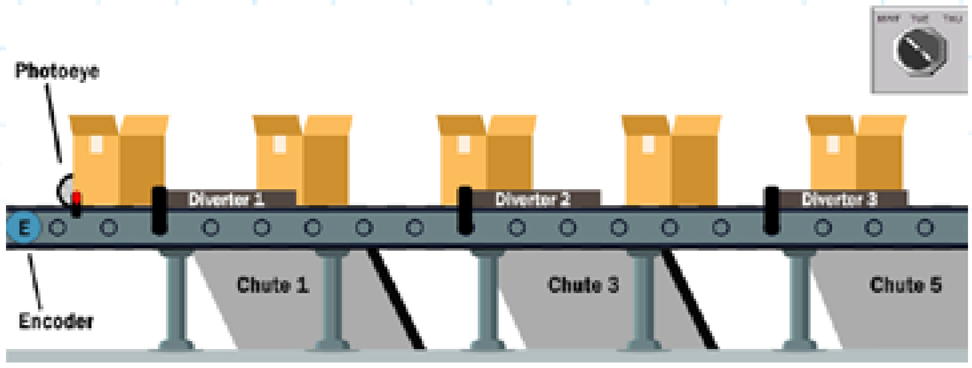
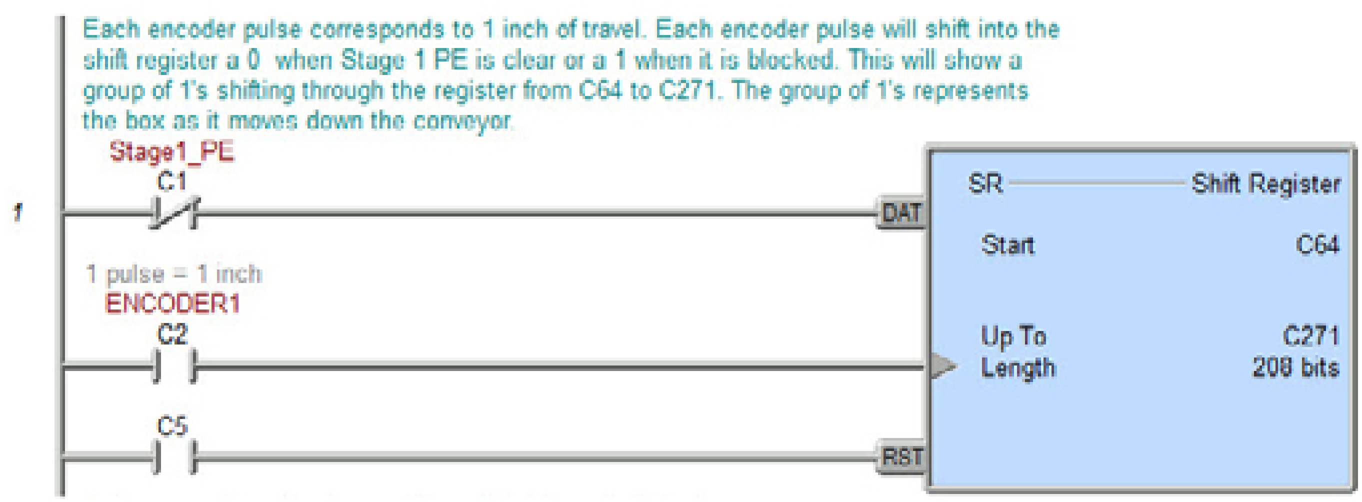
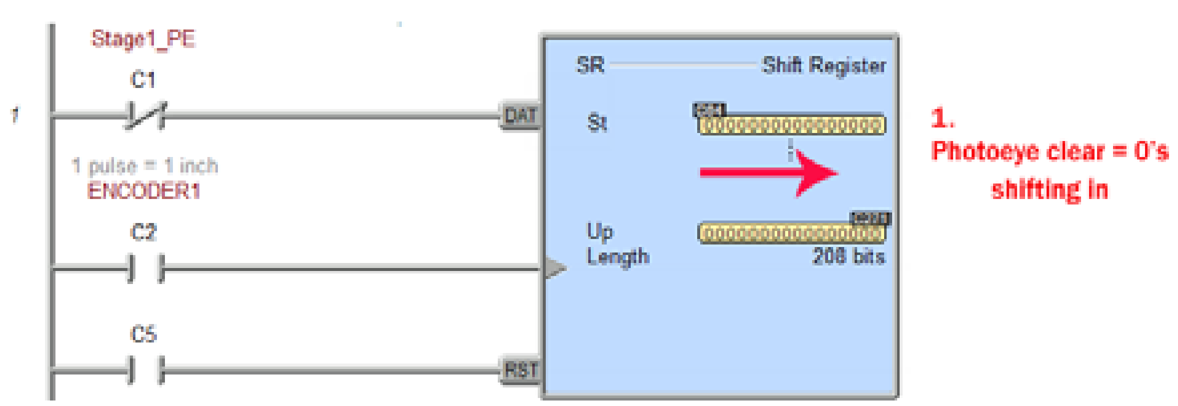
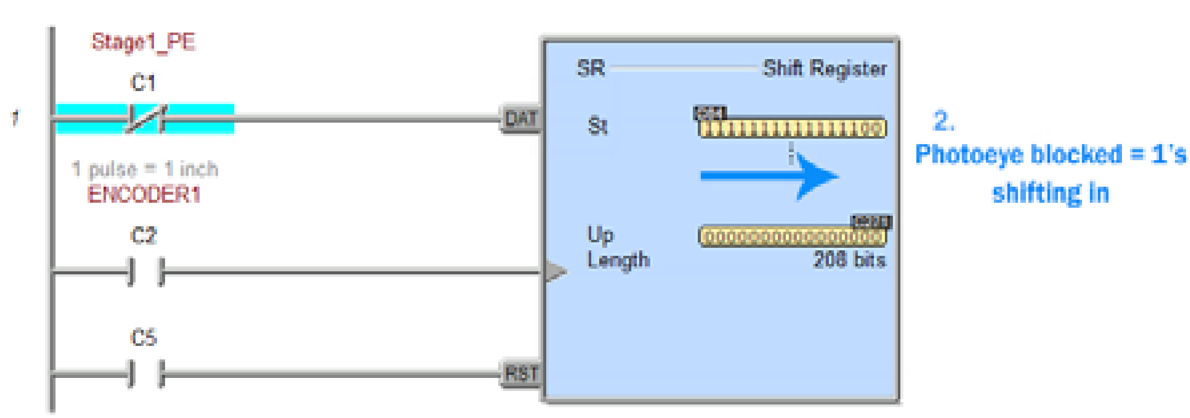


Above is a diagram of the package handling conveyor system we will be controlling. The photoeye is right up front, so we know when a box is present, and the three diverters are positioned at different locations along the belt. We also have an encoder mounted to the conveyor and our chute selector switch is there as well. The whole conveyor line is approximately 17 feet long. Chute 1 is the outbound chute used during Monday, Wednesday and Friday operations. Chute 3 is used on Tuesdays for inbound processing. Chute 5 is used on Thursdays to feed the international package line. What about Chutes 2 and 4 you ask? Well, let's just say they are manually controlled and used during peak seasons so we will ignore them.

First, in order to track the position of the box(es) on the belt I will use a shift register. As you can see in the code below, I will shift the shift register with every encoder pulse. By making each shift equal one pulse I am essentially making each shift equal one inch of travel. Since I know the location of my diverters in







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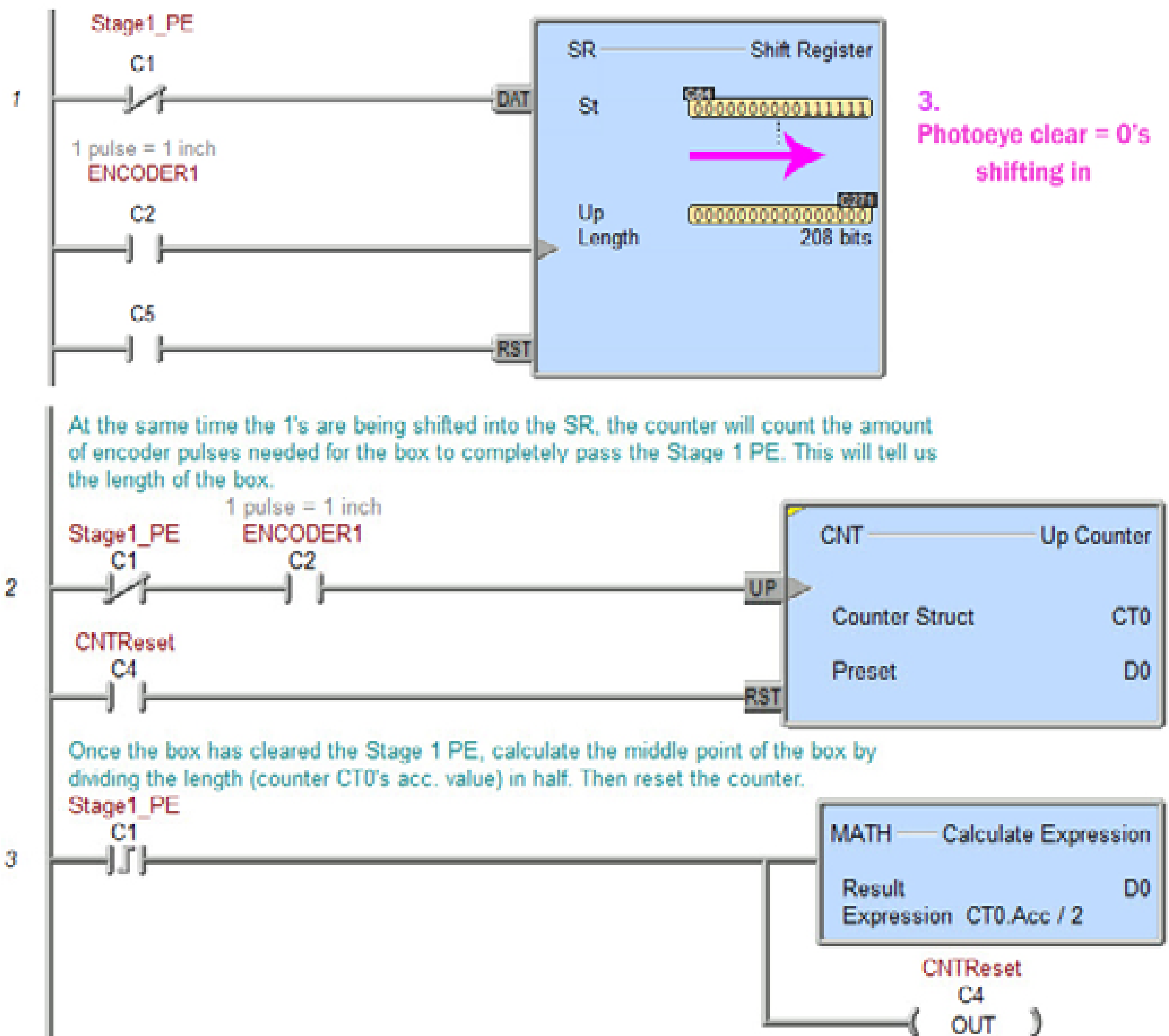

inches from the start of the belt, I know the exact bit in my shift register that corresponds to the diverter location I am looking for. For example, the middle of Chute 3 is 8.333 ft or approximately 100 inches from the start. My shift register starting bit is C64, so the bit I am concerned with for Chute 3 is C164, in other words, it's C64 + 100 shifts.

The photoeye will determine whether a 1 or a 0 is shifted into the register. When the eye is clear, 0's will be shifted in and when it's blocked 1's will. This creates a group of 1's, that represent the box, being shifted through the register, which represents the length of the conveyor belt. As soon as the C164 bit has a 1 shifted into it, I know the leading edge of the box has arrived at the middle of Chute 3.

Now when using diverters, it's important that you do not fire too early on the box since it could be crushed against the side wall or too late since it may just spin and not fall down the chute. You want to aim for the middle of the box. To do that, in the next set of rungs, I'm calculating the middle point of each passing box. The counter in rung 2 will increment the count, while the photoeye is blocked, for each inch the encoder moves. This will count the number of inches needed for the box to completely pass the photoeye or, in other words, it supplies the length of the box in inches.

Once the box clears the photoeye, in rung 3, I then take the length counted and divide it in half to get the middle point. The middle point is stored in D0 and the count is reset for the next box.

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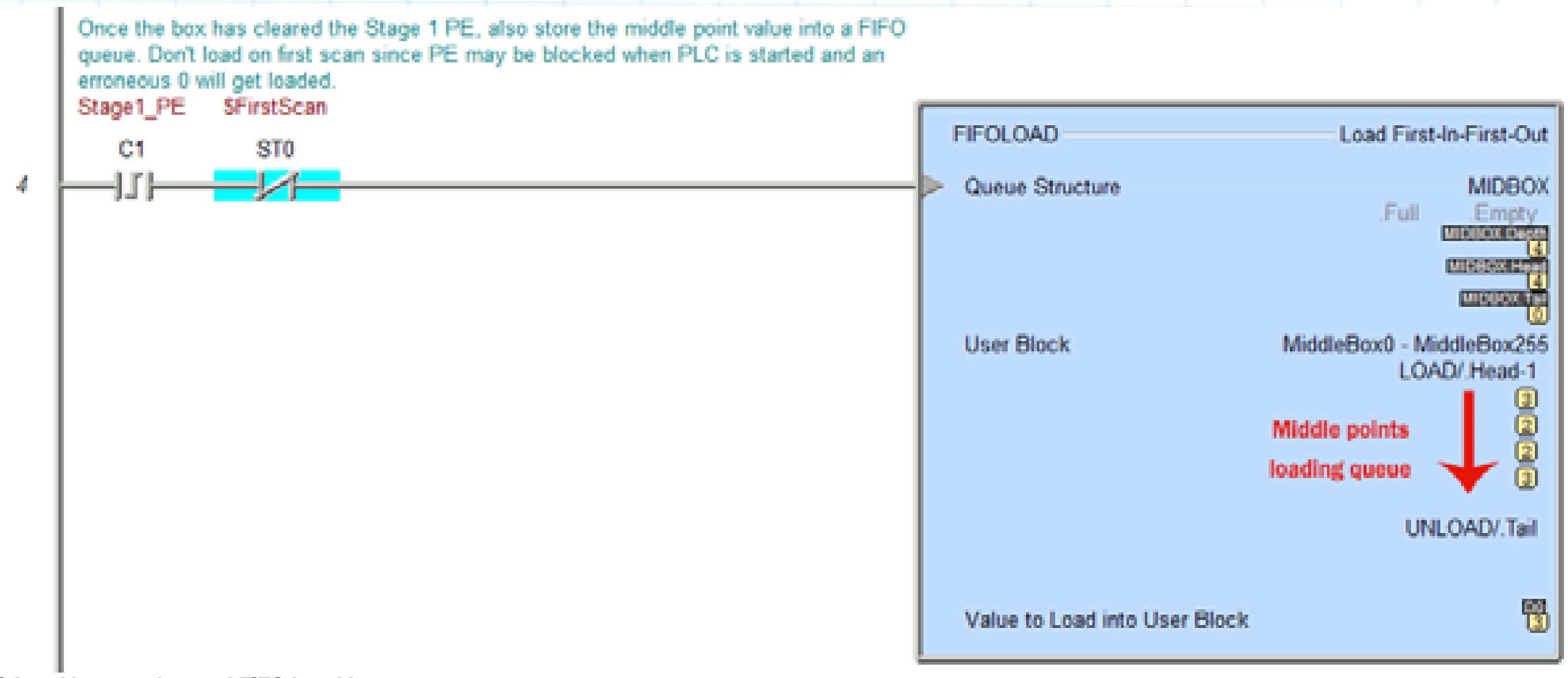
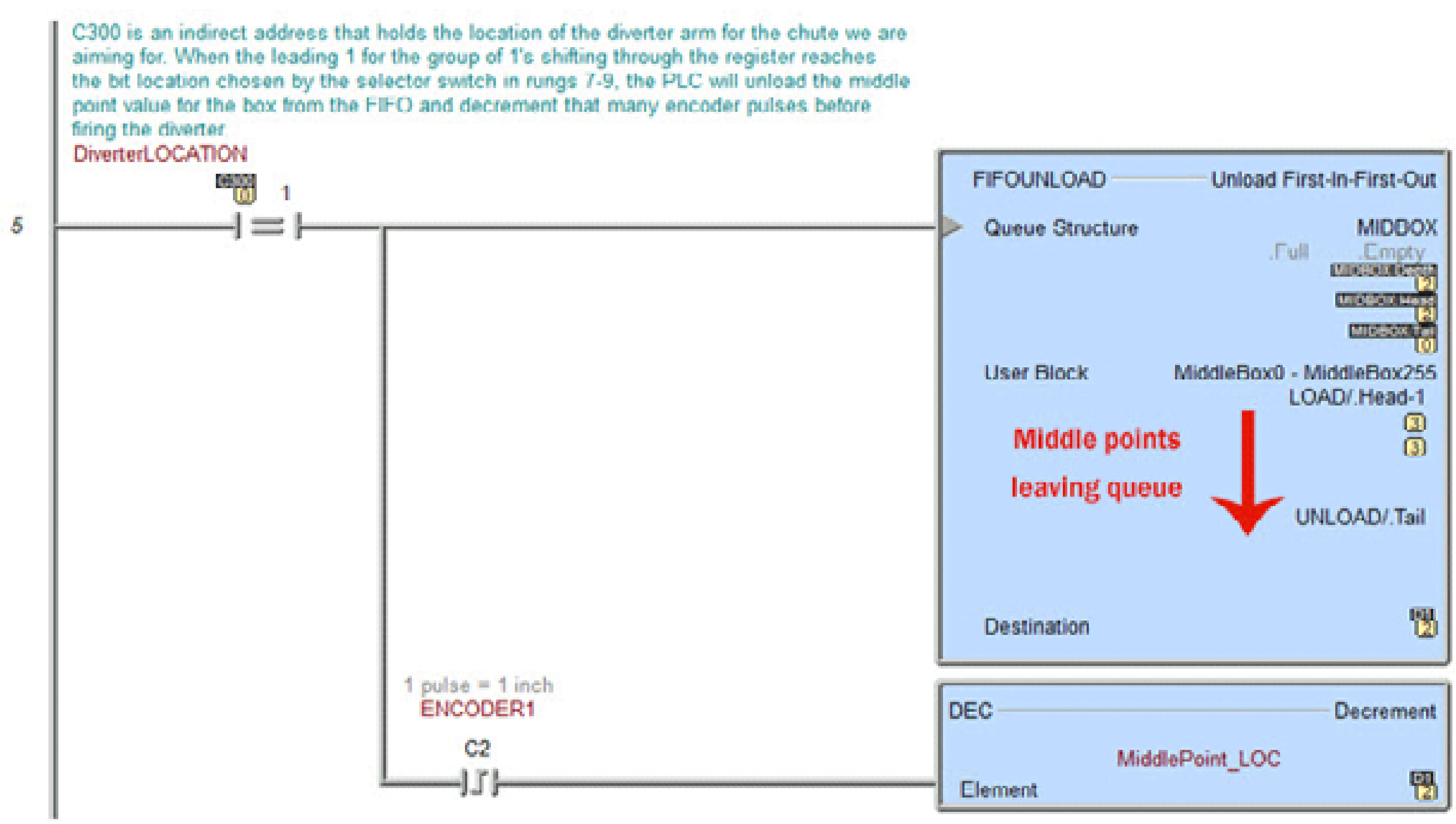


FIFO Load instruction and FIFO Load in progress.



FIFO Unload Instruction with FIFO Unload in action

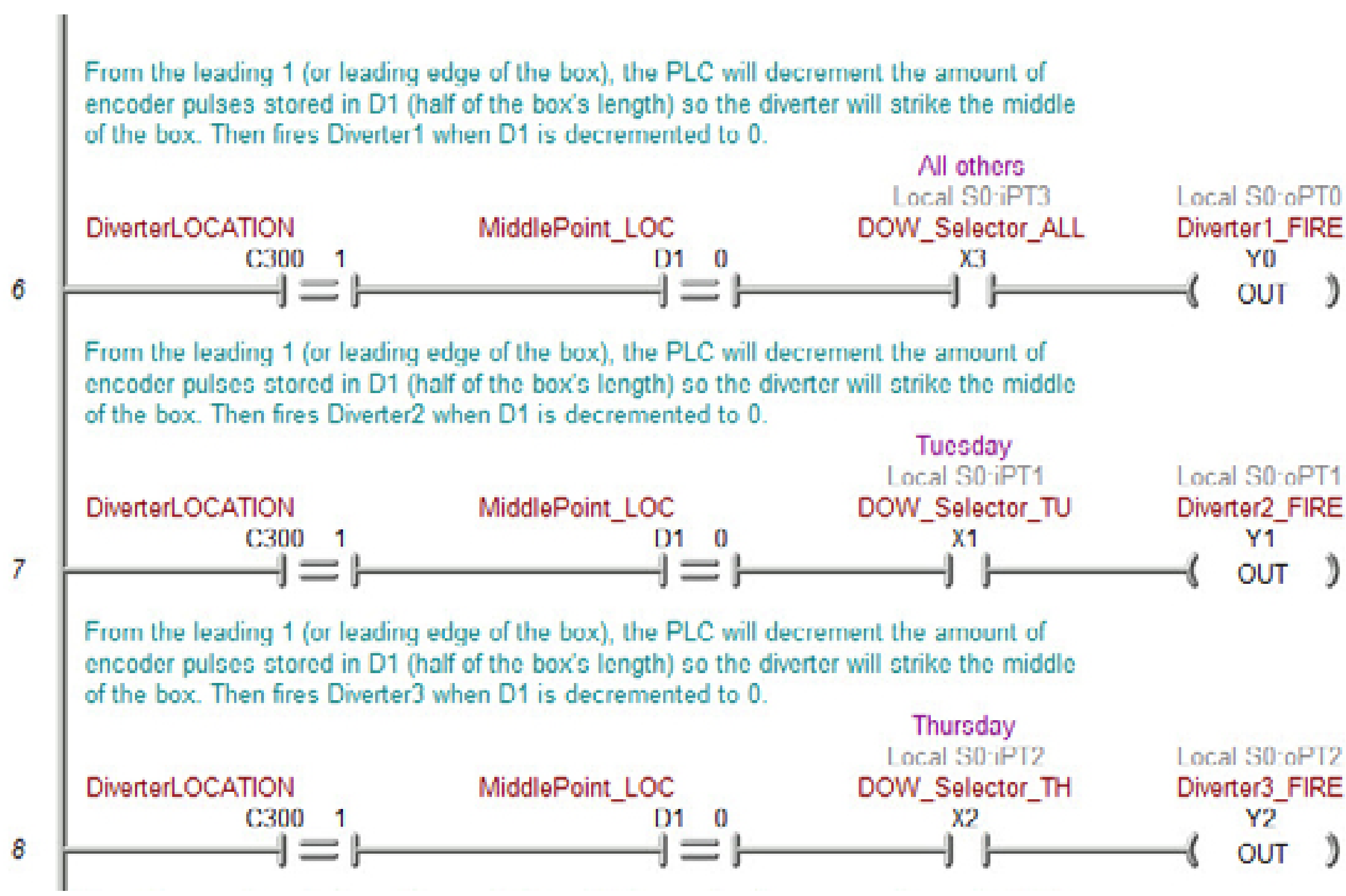
Mind your Ps and Queues

In a normal package handling operation, there are many packages being conveyed and diverted. To keep track of the numerous middle points I could have, and to keep them in sequential order, I queue up these values using the FIFO in rung 4. Once each box clears the photoeye, the middle point for that box is loaded in the FIFO queue. Then the next middle point is loaded and so on. The FIFO queue is set up to hold 255 middle points, which for our facility is more than needed for this conveyor line.

On the other side of the FIFO, rung 5 will unload one value from the queue when the leading

continued >>

edge of a box (represented by the first 1 in the shifted group of 1's mentioned earlier) has reached the register bit that corresponds to the needed diverter. C300 is being used to hold the value of the bit in the shift register that pertains to the correct diverter location. This is done so the selector switch can change the register bit for the required diverter. As mentioned previously, Chute 3's bit in the shift register is C164. When the leading 1 in the group of 1's being shifted finally reaches this bit, the middle point value for that box will be unloaded. That value is then decremented once with each encoder pulse to delay the diverter firing until the box moves the correct number of extra inches along the belt. This will make the diverter arm strike the middle of the box as opposed to the front. Rungs 6,7 and 8 will turn on the output to fire each diverter as selected by the selector switch. To do so, the corresponding shift register bit must see a 1 and the middle point value must have been counted down to 0.



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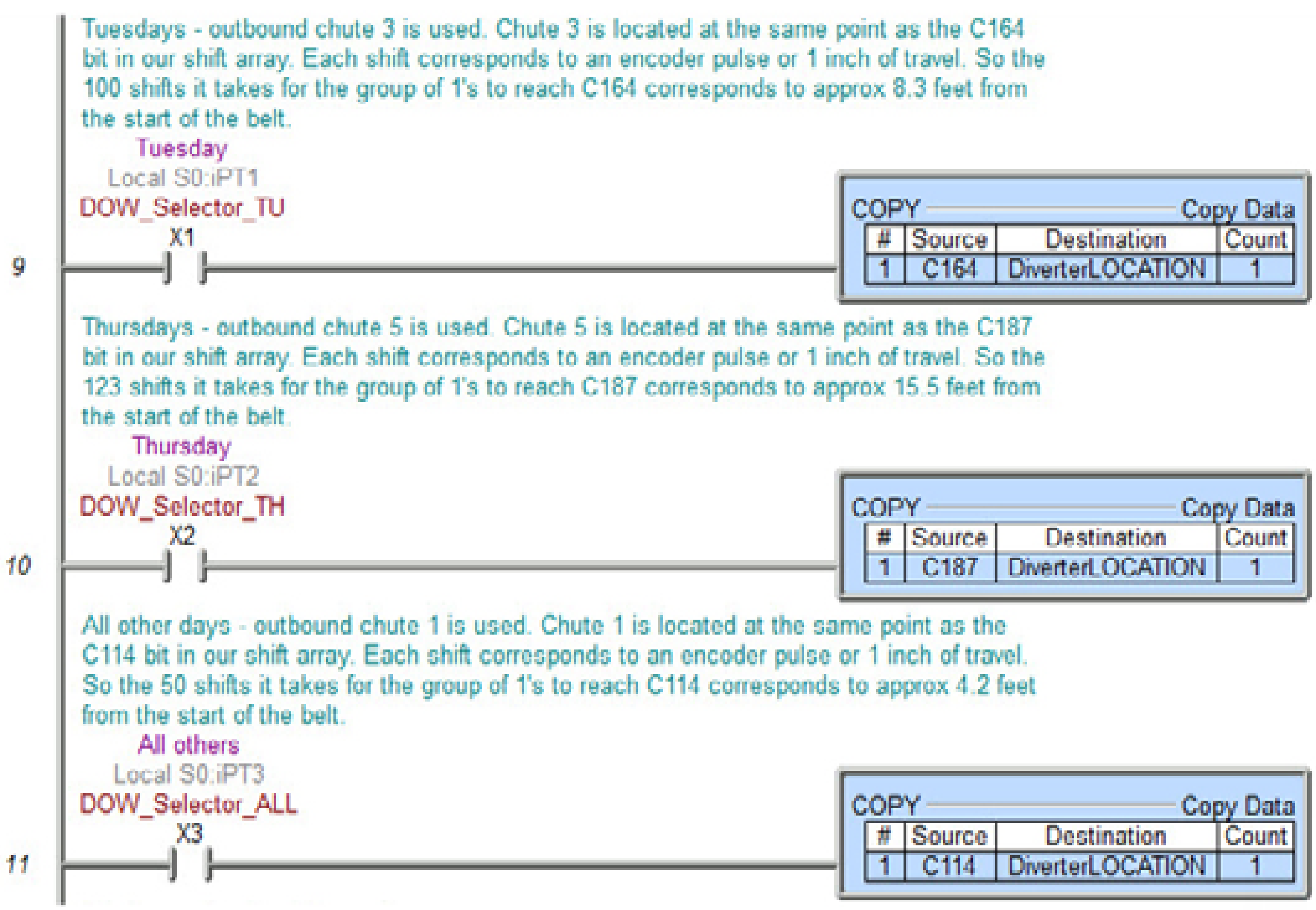
Rungs 9, 10 and 11 will choose the correct shift register bit value to load into C300 depending on what position the selector switch is in. We know C164's value is loaded for Chute 3 and we can see in this rung that C114's value is used for Chute 1 and C187's is for Chute 5. Those bit locations in the register correspond to the 4.2 ft. distance to Chute 1, the 8.3 ft. distance to Chute 3 and the 15.5 ft. distance to Chute 5 from the starting point of the conveyor.

And that's it! Each package loaded should be diverted to the appropriate chute. As mentioned previously, there are many ways to go about coding an application such as this. The way I did it here is just one of the ways it can be done. Regardless, as you can see, the shift register and FIFO instructions within the Do-more Designer software made quick work out of coding this. Although I did not discuss it much, the project simulator was also a giant help. If you would like more information on the FREE Do-more Designer software or the Do-more BRX PLC, head on over to www.BRXPLC.com.



ADC Employees Share Knowledge and Experience in STEM and Education Initiatives

Fifty years ago in July, United States astronauts Buzz Aldrin and Neil Armstrong became the first humans to walk on the moon. That amazing accomplishment was the result of a major commitment, focus, and funding of "scientific and technical manpower" that President John F. Kennedy called for just eight years earlier in a speech before a joint session of Congress. In a speech about the growing space program a year and half later at Rice University in Houston, Texas, he expanded on that commitment. "We choose to go to the moon in this decade and do the other hard things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills."

At AutomationDirect, we believe that a focus on science and technology in schools – indeed on education overall - continues to be an important commitment five decades later. That's why employees routinely share their time, knowledge, and experience via education initiatives in our community. Their efforts to help students learn first-hand about engineering, cybersecurity, and marketing, to name a few business areas, are outlined below.

CyberPatriot/Alliance Academy – AutomationDirect cybersecurity employees mentor students at the Alliance Academy for Innovation in the CyberPatriot program, part of the National Youth Cyber Education Program. They help students develop the critical thinking, problem solving, teamwork, and communication skills needed to accomplish a common goal. In this case, that goal is participating in the National Youth Cyber Defense Competition which offers scholarships and education grants for winners. This year, five Alliance Academy teams of five to six students each participated in the competition. All of them advanced to the state level of competition, and four teams went on to the semi-finals.

"As mentors, we are able to help the students explore a career path and jumpstart their training and education before entering the workforce," said Jason Wright, who works in cybersecurity at AutomationDirect. "As it becomes more difficult to find quality cybersecurity professionals, this program also allows AutomationDirect to see the students that are advancing and offer them potential internships or career opportunities."

FIRST Robotics Competition – For the past 13 years, AutomationDirect has sponsored FIRST Robotics programs in Forsyth County, GA schools. FIRST's mission is to inspire young people to be science and technology leaders and innovators, by engaging them in exciting mentor-based programs that build science, engineering, and technology skills, that inspire innovation, and that foster well-rounded life capabilities including self-confidence, communication, and leadership. Forsyth County Schools' initial goal was to have one team in each school. Now, the program has grown to a whopping 163 Robotics teams throughout the system.

Team OTTO at Forsyth Central High School is the original Robotics team that AutomationDirect sponsored. In 2006, the team members designed, built, and competed with their robot. Eventually, the team placed 24th in the World Competition - an amazing accomplishment. Senior Technical Marketer Rick Folea has worked with the Robotics teams since the beginning and knows the benefits it offers to both students and companies.

"When Robotics team members visit AutomationDirect and see the robots fulfilling customers' orders as quickly and as efficiently as possible, they are amazed," he said. "Watching the robots in action is a huge crowd pleaser. The students can experience firsthand how robots can help businesses, giving them a vision for a possible STEM career. We've now seen kids go through these programs,

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major in a technical field in college, and then come back to the community with stronger skills that employers need."

One of the original members of Team OTTO now works at AutomationDirect, while another Robotics team member is a middle school STEM teacher. "It's wonderful to see the program come full circle and show success," Folea said.

Matthew Dean receives the "Internship Innovation Award" for recognition of excellence in employment.

Forsyth County Education Foundation – Tina Gable, Advertising Manager for AutomationDirect, has served on the board of the Forsyth County Education Foundation since its inception in 2015. The foundation's mission is to unify community resources, not necessarily provided by the school district's operating budget, that foster innovation for increased student achievement. Since it began, the foundation has provided $180,000 in grant dollars to support innovative teaching and increased student achievement in Forsyth County Schools. Gable most recently helped the organization raise additional money for grants via a "Duck Dive" in which people donated money to sponsor a rubber duck in the Fourth of July event. The program raised in excess of $80,000 to fund education grants in this upcoming school year.

Forsyth County Education Foundation's "Duck Dive" fundraiser to raise money for Forsyth County Schools.

Internship Forsyth (formerly called Work Based Learning) – Forsyth County Schools recently changed the name and branding of this program to Internship Forsyth to better describe all the aspects it offers to students. The program pairs Forsyth County high school students with structured work experiences that connect their career goals and pathways with a productive work environment. Students get the opportunity to tie what they learn in school into a real-world worksite, enabling a smooth transition into the workforce and/or education beyond high school. For the past two years, AutomationDirect has hosted interns in various departments. Currently, two interns

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work at the company, one in Marketing and one in Engineering.

"AutomationDirect is a prized work location for interns as the employees provide great work experience, communication and feedback to the students," said Debra Moore, Career Development Coordinator, with Internship Forsyth.

Moore also noted that the program provides students the opportunity to check out the career path they are interested in before they get to college. "Many students come in and think they know what they want to do," she said. "By the end of the internship, they either love that path or want to change careers. That's important, because changing majors in college can be expensive."

Project L.I.F.E. – AutomationDirect partners with Forsyth County Schools to provide community-based job skills training for students aged 19 years, 8 months to 22 years with cognitive or developmental disabilities. Project L.I.F.E. (Learning Independence for Future Employment) focuses on vocational training by providing real-world and hands-on job skills applications. It prepares them for the transition from high school to independence and competitive employment. The interns help approximately 20 AutomationDirect Logistics team members with their work and are there most days when school is in session.

Continued Focus on Education Brings Many Benefits

AutomationDirect is proud of how its team members share their knowledge and expertise with students in real-world STEM and business experiences. It's an important part of continuing the focus that President Kennedy set. "The growth of our science and education will be enriched by new knowledge of our universe and environment, by new techniques of learning and mapping and observation, by new tools and computers for industry, medicine, the home as well as the school," he said at Rice University. His vision marshalled the resources to develop new technologies and solutions that ultimately carried our astronauts safely to and from the moon. AutomationDirect is honored to be able to continue this important education mission. Look for more information about these programs in future blog posts.

Mobile is the New Normal

Most plant floor workers already carry mobile devices, so using them to access, control and monitor equipment is a natural next step.

The September 2018 issue of Control Design magazine featured a cover story spotlighting new and better ways for delivering a mobile industrial operator interface experience. Titled *A Better Interface*, the article presented input from hardware and software suppliers, and from system integrators, describing how they are moving to mobile for industrial automation applications, and that story is adapted in the following sections.

Office workers commonly have one or more mobile devices close at hand, and the trend of companies endorsing a bring-your-own-device (BYOD) policy is growing. As mobile becomes blended for personal and business purposes, it is inevitable that industrial plant floor workers will continue to follow suit and use the technology for human-machine interface (HMI) control and monitoring of machines (*Figure 1*).

As a result, mobile technology is making industrial systems more usable and even social, enabling productive worker collaboration.

Fingertip Control

Systems integrators tasked with applying the right technology to deliver results are right where the action is. "Think about the computing power readily at hand when using smart phones or other mobile devices loaded with apps," says Hayden Serio, senior engineer at Maverick Technologies, headquartered in Columbia, Illinois, and a member of the Control System Integrators Association (CSIA). "In addition to phone calls, email, text messages and pictures, these devices can be used for taking notes, downloading documents or even digitally entering and storing round sheets, among other capabilities. Why not take it a step further and use mobile-app technology for real-time data analysis and reporting, system monitoring, diagnosing and troubleshooting potential problems?"

App Experience
Figure 1: Machines and equipment on the plant floor are becoming more social, and, if not, the HMI is at least app-like, working on smartphones and tablets. (Source: Universal Robots and Hirebotics)

continued >>

Serio goes on to describe how mobile applications can influence reliability programs. "As automation professionals make the rounds using mobile technology, they can make informed data-driven decisions in real time about manufacturing systems and processes, improving overall operational efficiency," he notes.

Today's operators already comfortably consume information using personal mobile devices, so using those as HMIs is a natural step, points out Rob Goldiez, co-founder of Hirebotics in Nashville, Tennessee, a certified system integrator (CSI) of Universal Robots. "Our users consume machine status, production data, quality data and much more," says Goldiez. "We have the ability to convert machine status into human readable messages that are delivered in real time via push notifications" (*Figure 2*).

Mobile HMI
Figure 2: Maintenance information such as cycle counts, run time and maintenance schedules can be made available to ensure preventive maintenance is completed on schedule. (Source: Universal Robots and Hirebotics)

No Time Like the Real-Time

"With mobile apps, real-time data can be delivered to associates in real time, wherever they are," according to Nate Kay, project manager at Martin Control Systems in Plain City, Ohio, a CSIA member. "They no longer have to be standing in front of the machine to access this data. If there is an issue with a machine, it is often possible to troubleshoot that issue before setting foot on the plant floor. This can speed up recovery and minimize downtime."

Mobile apps enable operators and maintenance personnel to work almost anywhere and access the information they need. "The operators can control equipment while being near it," points out David J. Stock, president at Innovative Control in Algonquin, Illinois. "It also reduces foot traffic needed when constantly returning to a control room and provides the capability of monitoring the process from any location within a facility."

Mobile devices also enable other extended options. "The device can have additional functionality by leveraging barcode scanning and RFID technology," adds Stock. "We leverage this to confirm operator presence, even to issue commands to the system. For process control, users can stay with the process and be connected to the same information and functionality that a control room would have."

Built for Users

"Small, handheld mobile devices can show users, such as operators or managers, what they and the engineering and technical teams need to know," continues Stock. "But this should be handled completely differently compared to control room SCADA/HMI displays. The displays should be designed/architected for their size and purpose—primarily focusing on text-based views instead of equipment graphics or P&ID-based views. Focusing on a more text-based design enables the maximum usage of the small footprint, allowing several pieces of information to be displayed, and interfaced with, rather than just equipment status."

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In most cases, typical HMI/SCADA navigation styles should not be applied directly to mobile apps, which instead should be designed to improve focus on important information, according to Stock. "Mobile-app navigation should flow intuitively to minimize training and button clicks. Typing on the mobile devices should be minimized, as well. Barcodes and QR codes reduce errors and operator frustration," he concludes.

Using contemporary high-performance HMI methods to minimize distracting objects and colors is key for displaying critical equipment information, explains Serio at Maverick Technologies. "Using these HMI techniques helps users to view the important information they need on small, handheld mobile devices."

Useful information is not the same as raw data. "It takes analysis and interpretation to make data valuable," explains Serio. "Trending is one way to visualize data over time and allows you to analyze recurring patterns and go beyond the current machine status. Being able to see multiple measured parameters over time will allow users to use their experience to make informed decisions about equipment."

Far greater value can be realized by analyzing many similar systems networked from different plants, processes and machines, claims Kay at Martin Control Systems. "For example if I only analyze the data on one machine, that tells me a lot about that individual machine," he points out. "However, if I correlate the data from many machines and compare that data with data from across the company, then I can start asking and answering questions such as: How can I improve my overall process? What are areas where efficiency can be improved? How can I improve efficiency? What are the causes of downtime? Why does Machine A seem to run better than Machine B?"

Collaboration is the Next Step

"Machine-specific information related to geospatial location, technical information and current and historical alarm status of the connected machines can all be weaved together via a configurable dashboard application and can be customized as needed for specific user roles and scenarios," asserts Mike Malone, principal of Technotects (*www.technotects.com*) in Harleysville, Pennsylvania (*Figure 3*).

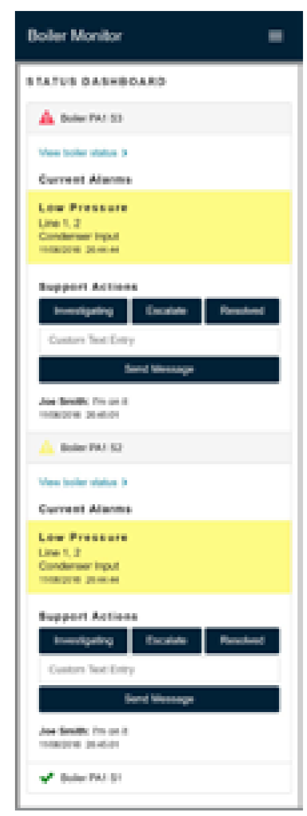

Figure 3: Collaboration options
Mobile HMIs are ideal for integrating a social media aspect, allowing operators to collaborate directly in new ways. (Source: GE and Techootects)

"These applications automatically scale to the size and shape of the mobile device, allowing the user the freedom of using BYOD. Mobile machine apps typically have a social media aspect to them, as well. The various team members that are tasked with supporting the machinery can interact and collaborate directly through the apps using simple text-messaging or through videoconferencing technologies such as with Facetime and Skype. These interactions are then logged into the case that gets created for the downtime condition. When confronted with a similar case in the future, technicians can quickly review the case and determine how the issue was resolved previously. It's all about improving the productivity on the plant floor".

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Any Time, Any Place

"Mobile applications are well suited for communication with many different devices," points out Serio at Maverick Technologies. "Wireless protocols, such as Wi-Fi and Bluetooth, make connectivity quicker and cheaper to obtain than older hardwired methods. Couple this with the Industrial Internet of Things (IIoT) technology, and you can create connections to machines, processes and plant systems very quickly. With the IIoT, the sensors and controllers that monitor and control industrial equipment have connectivity built-in; therefore, end users can connect to them via the manufacturer's mobile applications. Sometimes, they can even connect via a simple Web browser. It is critical to keep cybersecurity in mind as increased connectivity comes with a greater responsibility to protect these connections from cyber-attack."

Information technology (IT) workers commonly make use of virtual private networks (VPNs), virtual local area networks (VLANs), industrial demilitarized zones (DMZs) and firewalls. These same IT technologies are now regularly applied on the back end for operations technology (OT) use, according to Kay at Martin Control Systems. "On the front end, many HMI and SCADA software packages have a mobile app plug-in for quick access," he explains. "These apps make it possible for end users to quickly select the machine, process or plant they want to access using their mobile device."

Security Requires Careful Attention

"All devices on networks, including control systems, have some inherent security risk, whether or not mobile apps are used," cautions Kay at Martin Control Systems. "However, if designed properly security risks can be minimized. Anytime we shop or do banking online, there is some security risk. Yet many people still shop on Amazon and check their bank accounts using their mobile devices as the risk is small compared with the benefits. Additionally being able to monitor and access your data in real time through things like mobile apps can increase security in the same way that a credit-card company can alert you to fraud by monitoring your data."

One crucial consideration is that many industrial automation systems, even if mobile connectivity has not been implemented, may already have unexpected risks for cyber-attacks, explains Scott Cunningham, product and application manager, controls and automation, at KEB America. "Many machines reach the Internet, either intended or unintended. 'Was that old machine just connected to a production PC, which happens to have internet access?'" he asks. "It is important that the production floor also has security infrastructure in place as a baseline."

One approach to incorporating mobile connectivity is to use dedicated devices configured to be isolated from the internet and business networks, according to Stock at Innovative Control. "Or don't allow equipment control and sensitive material to be available on the mobile app," he says. "If outside network/Internet is required on the mobile device, this would require a DMZ bridge between the automation system and the business/Internet to further prevent possible intrusion and viruses."

Cybersecurity should always be a prime consideration, maintains Serio at Maverick Technologies. "Any connected system should have it built into its design," he instructs. "Hoping for 'security by obscurity' is no longer a valid approach to cybersecurity. IT managers should start with a robust network-security architecture that incorporates defense-in-depth strategies, as well as smart-domain policies. Over the past several years, however, mobile technology has matured so that more security options are available. The arrival of the Internet of Things and the Industrial Internet of Things has pushed manufacturers to integrate security down to the device level, rather than relying solely on secure infrastructure."

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Making an HMI Mobile

Mobile HMIs should maintain consistency with typical apps for best operator acceptance. "We use mobile apps, as well as desktop access to Web servers embedded in the equipment," explains Rick Lamb, president at Midwest Technology Ventures, a technology-focused system integrator in Indianapolis. "In fact, I'm setting up a client project right now with mobile-app access. It's a material call application in an engine-assembly plant. Wireless pushbuttons are located in the assembly cells, wherever it's ergonomically convenient for the operators. They push a button, and it sends a material call signal for the specific part they need."

"There's an iPad in the assembly area, allowing operators to view the material call status," adds Lamb. "Material handlers have iPads on their forklifts, as well. They see a queue of the materials needed. When they go to the storage area, somebody has already picked those materials for them based on the assembly line calls, so the handlers can quickly deliver needed material to the workstations."

In this case there is no dedicated mobile app, because web server code generates the user's iPad view. "The material call system is pretty much custom-coded; data is kept in an Oracle database; and the material requisitions are interfaced to the warehouse/inventory management system," Lamb explains. "The server is a virtual server in the IT department; it serves up the Web pages to the iPads."

Apps Provide HMI Advantages

The traditional plant floor filled with a variety of purpose-built HMI devices already raises concerns, points out Malone at Technotects. "The security risk and support headache associated with patching and maintaining all of these HMI devices is becoming troublesome," he notes. "A well-designed mobile application, which connects and collects all of the plant-floor machinery data into a single, simple-to-use user interface, will undoubtedly improve manufacturing productivity and unshackle the operators from their installed HMI screens and associated logins. The use of mobile-device apps has drastically improved consumer and commercial productivity, and it is just common sense that the industrial space will benefit just as well. Just as a driver can navigate around trouble spots on the highway using GPS-guided and crowd-sourced apps such as Waze, thereby improving his personal productivity, a process technician can avoid upstream issues and save a batch by rerouting the process. Having access to critical machine and process data and getting immediate alerts on your mobile device regardless of your location is key to reducing downtime and improving overall productivity."

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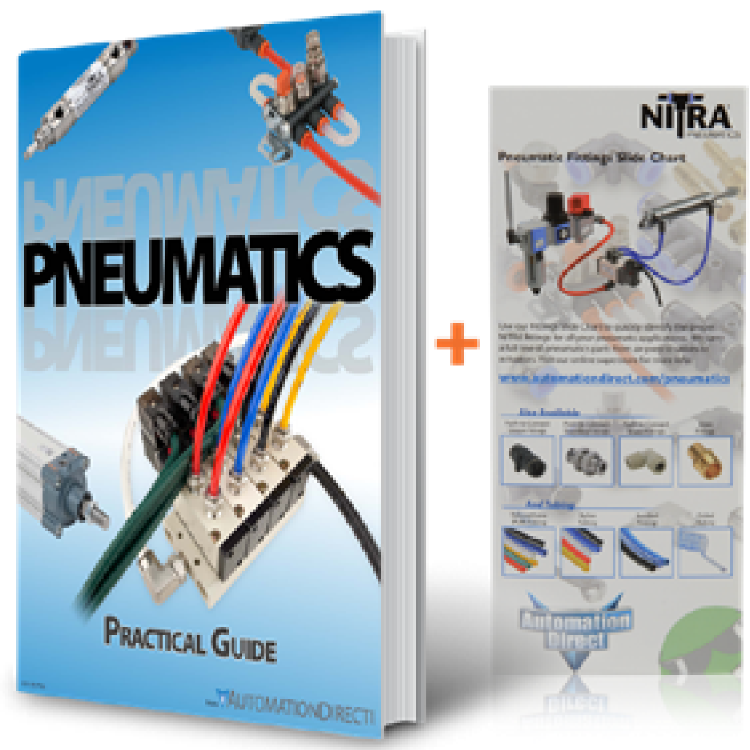

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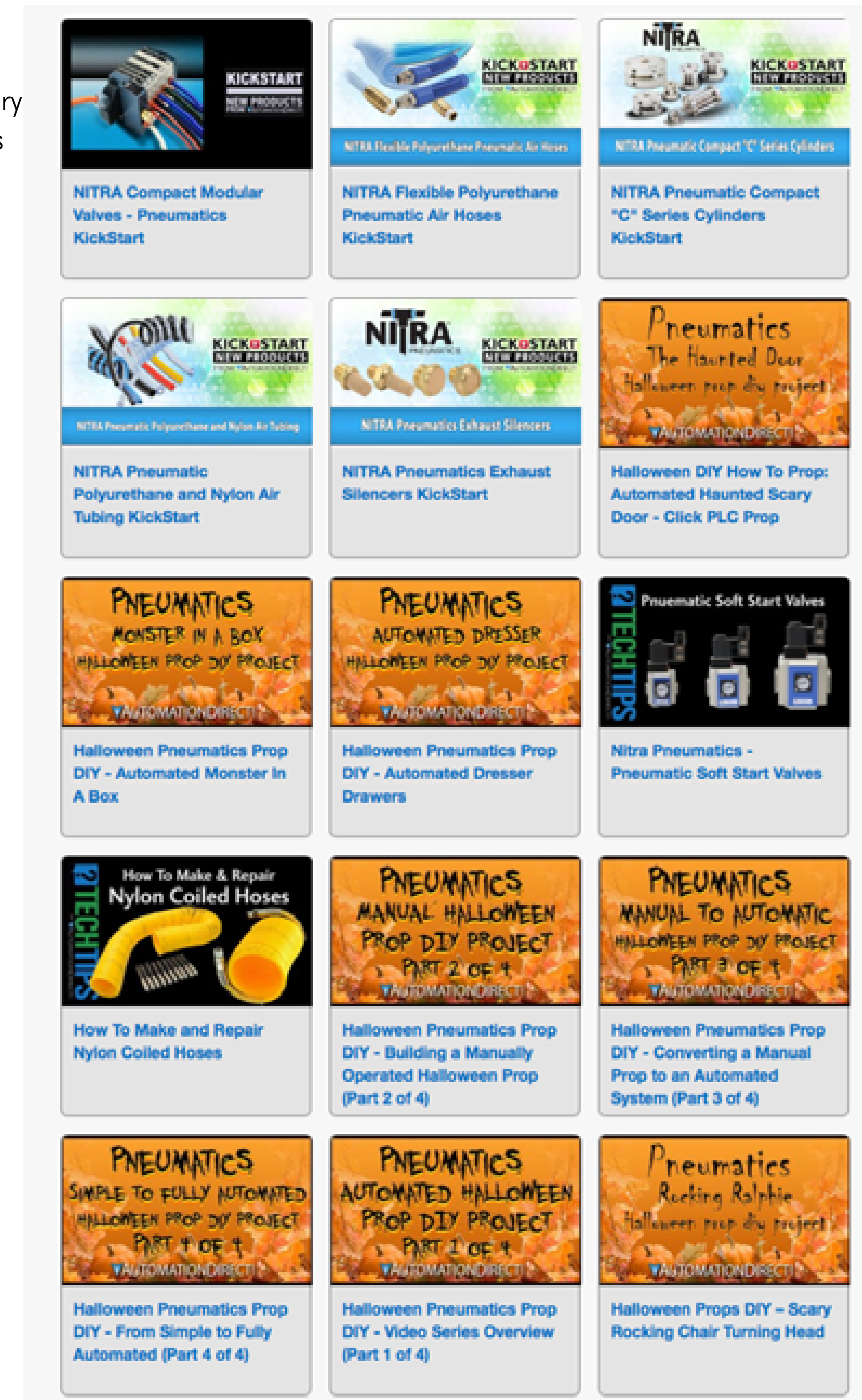

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Crushing the Control System

Upgrading to a modern control system platform with the help of a local system integrator transforms a rock crushing plant from manual to fully automatic operation.

By Todd Timpa, Assistant General Manager at CTC Crushing

Impact Sand and Gravel is the leading supplier of aggregate and sand in the Las Vegas area, producing and distributing millions of tons of material to construction trades each year. The company began in the 1990's by brokering sand and gravel before eventually entering the production side of the industry.

Production started with a small crusher and one gravel pit surface mine, and this has since grown to four gravel pits and crushing plants (*Figure 1*). CTC Crushing is staffed with highly trained technical personnel, heavy machinery equipment operators, welders, electricians and mechanics.

Figure 1: CTC Crushing Processes Overview
The surface mine at the top of the photo feeds CTC Crushing's dry processes. The wet process at the bottom left of the photo feeds washed final product to the bulk storage piles, which are not shown.

Recently, CTC recognized the need to upgrade its crushing plants to better support custom products because reconfiguring to run different products often required time-consuming changes to the control system and extensive rewiring. To modernize and simplify control of their dry and wet plants, CTC Crushing partnered with InterConnecting Automation, an AutomationDirect system integrator, to upgrade an aging, inflexible and highly manual control system into a modern and easy-to-configure design.

Turning Rocks into Gravel and Sand

Simply put, CTC turns big rocks into small ones. At the gravel pit, the native material is surface mined down to between 50 to 100 feet under grade. When mining is complete, the area often is converted into a retention basin for storm water or a sports facility.

Initially, the entire industry's source material was native and virgin, and companies mined the material they crushed. Over recent years, a large part of the industry has transitioned to recycle by obtaining concrete and excess material and then reprocessing it. CTC operates both recycle and virgin material plants, producing aggregate for road bases and dry sand for landscaping. Washed native material, concrete sand, washed rock products and golf course materials are part of the operation, as well as concrete recycling.

Material is processed on-site. Equipment crushes the rock to a specific size and washes the sand, then the resulting material is stockpiled, and eventually trucks deliver the product to end users or brokers. As the largest rock supplier in Las Vegas, many end users purchase materials directly from CTC.

At the facility near Boulder City, NV, new control systems were recently installed on the crushing and washing processes, while the clarifier (water reclamation) control system upgrade is in process.

The dry process features a primary crusher handling material brought into the plant. This material enters the primary jaw crusher sized at 24-inch minus (all material is 24-inches in diameter or less) and its output is six-inch minus, which in turn feeds a secondary cone crusher to take that material

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down to three-quarter inch, one-half inch or less depending on the crusher's configuration. Two additional vertical shaft impact crushers are used to make sand down to 1/8-inch minus (*Figure 2*).

Figure 2: Vertical Shaft Impact Crusher
The dry process vertical shaft impact crusher uses twin 400 hp motors to crush 1.5-inch rock to 1/8-inch minus sand that is fed to the wet plant.

From the dry crushing application, material is conveyed to the wet process where the material is washed through auger screws (*Figure 3*). Transporting the material through the spinning screws with water added cleans out the mud. The muddy water is then transferred to the clarifier process to remove the mud so the water can be reclaimed and reused.

The finished product is moved by conveyors in its wet state and stockpiled, ready for delivery to the customer.

A Crushing Automation History

About 20 years ago, CTC implemented a motor control center (MCC) operated by a programmable logic controller (PLC) using the DeviceNet industrial communications protocol. This was a relatively new method at the time with few installations. The system worked well and ran the entire plant, but was difficult to operate, maintain and support. An emergency stop or electrical issue might require a technician to fly out from the East coast to correct the problem.

Figure 3: Material Washer
Wet process auger screws wash the rocks or sand with water.

The original control system was very difficult to troubleshoot but was used for many years. Eventually it was running so poorly that about eight years ago the plant moved away from automation and went back to more of a manual system. The manual system consisted of large start-stop pushbutton stations, and each of 50 motors had its own hardwired switch.

Control remained manual for about seven years until discussions started about modernizing the processes. This included equipment on both the dry and the wet side of the process, and later the clar-

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ifier. At that time, the manual system was easy to troubleshoot and operate, but management wanted to investigate the benefit of automating with contemporary PLCs.

Plant operations personnel were initially resistant to the idea of making the system more complicated again with PLC control, but they started looking online at different options when they realized a change was required. CTC had dealt with AutomationDirect over the years as an industrial component supplier, but not as a PLC supplier. Additional research revealed their new Productivity2000 series controllers were very capable of controlling processes such as those at CTC.

CTC personnel were already equipped to install the new automation equipment, but support was needed from an outside organization for specification and programming. Further investigation on AutomationDirect's website, specifically the section for PLC training and integration, identified Doug Bell at InterConnecting Automation as an integrator fitting the bill.

Processing Details

In the first phase of the project for System 1, InterConnecting Automation recommended, designed and supplied a Productivity2000 PLC system for just the wet process, controlling about 20 motors. This was a test case to prove the reliability of the system, explore how user-friendly it was, and confirm CTC electricians could successfully install it in-house without needing outside resources. The System 1 PLC has 51 discrete inputs, 55 discrete outputs, 4 analog inputs and 4 analog outputs. There is an EtherNet/IP digital communications link to a VFD, and a Modbus TCP/IP communications link to 10 scales.

Plant electrician Brandon Sembrick installed and wired the Productivity2000 system, and InterConnecting Automation programmed and started it up (*Figure 4*). The wet process control system was then tested for four months without failure

Figure 4: Productivity2000 Control System
CTC Crushing's electrician installed and wired the Productivity2000 controller in 15-slot racks to handle the high I/O count.

or equipment downtime.

After this wet plant test, reconfiguration of the dry side process began. A second Productivity2000 for System 2 was specified, installed, wired and programmed. This dry side process included control of close to 70 motors, from 400 HP in the crushers down to 5 HP on a few pumps and conveyors. This control system upgrade also went well. The System 2 PLC has 51 discrete inputs, 55 discrete outputs, 4 analog inputs and 4 analog outputs.

With two PLCs controlling close to 100 motors in the plant with no problems, CTC is now moving ahead to add a third PLC to automate the System 3, the clarifier portion of the plant. The System 3 PLC has 9 discrete inputs, 17 discrete outputs, 24 analog inputs and 1 analog output.

When the final phase is complete, the entire plant will be controlled by three Productivity2000 PLC systems purchased from AutomationDirect, programmed by InterConnecting Automation and installed and wired by CTC Crushing.

In place of operator control panels with about 100 start-stop buttons and lights, there are now two AutomationDirect C-more HMIs, each with onscreen virtual buttons to start-stop all the equipment. In addition, all the controllers and HMIs communicate with each other using a plantwide Ethernet network.

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The PLCs, HMIs and VFDs all have web server capability, allowing plant personnel to access these components via any browser to see data, make change and perform other tasks. For tasks required a higher level of access, the automation system can be remotely and securely accessed via AutomationDirect's StrideLinx Secure hosted VPN solution (Sidebar).

Rock Solid Control

The PLCs are controlling the system from beginning to end to bring material into the plant, control the crusher functions and speeds, operate material feed conveyors, and monitor motor amps and conveyor weights in various locations.

"The Productivity2000 was a great fit for this application," says Nick Bell, a programmer from InterConnecting Automation who wrote the code for both the wet and dry process PLCs. "It's I/O capabilities and networking were more than sufficient, and its 15-slot base was needed considering all the I/O on each system. Another important feature was the new Productivity Network (ProNET) which added the ability to share data between Productivity series CPUs. The feature is set up in the hardware configuration window. The data updates about 10 times a second, allowing for sharing of data among the PLCs at an acceptable rate for these processes."

Each program consisted of 50 latching circuits functioning as interlocks. The use of arrays, indirect addressing and relay logic allowed configuration of the interlocks via the C-more HMI, which enabled CTC to reconfigure functional aspects of the system by filling out a chart (*Figure 5*).

Control System Details

The HMIs each have five to six screen pages. Two of the screens are used for control and monitoring of the dry and wet plant. A configuration screen is used to configure VFD speeds in hertz, and another is used to monitor motor amps in the crushers and the belt weight scales by displaying tons per hour.

Discrete signals from the Productivity2000 PLCs

Figure 5: HMI Aids Operators
A mobile tablet device displays the C-more HMI screens, adding remote monitoring capabilities to the system.

control starting and stopping of the VFDs, while 4-20 mA analog output signals from the PLCs provide a speed reference to the drives. Current transformers connected to 4 - 20 mA analog inputs on the PLC monitor the electrical current used by the large crusher motors. This motor amperage data is used to determine if more product can be fed to the crusher. If a 400 HP motor is only drawing 200 amps, it can handle more work—more rocks—and make more product, maximizing production. The Productivity2000 PLC uses Ethernet communication to monitor the weight scales.

A big concern for CTC was eliminating downtime. With that in mind, electricians installed a hand-or-auto configuration for each motor. In the unlikely event that a PLC fail, a panel of relays enable switching all the motors from PLC control (auto) to manual start-stop control, using one latching relay for every PLC output. Therefore, it is still possible to use manual motor control capabilities as a backup, but this functionality was only used while starting up the new

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control system and has not been needed since.

Another CTC concern was the durability and longevity of PLCs and HMIs operating in the gravel pit environment. The PLCs are installed in control panels inside conditioned 40-foot trailers and the HMIs are in a control tower. Surviving the heat and dust of a Nevada summer was a concern, but there have been no problems. There is a lot of traffic in and out, but they have worked well in this harsh environment.

The Rock Bottom Line

Cost savings, flexibility and simplicity are the key reasons CTC chose AutomationDirect controllers and InterConnecting Automation. The system cost considerably less than other hardware and installation options while delivering high-quality results.

Their partners' flexibility allowed CTC to self-perform installation using in-house electricians. Experience indicated it would have cost over $100,000 to hire an outside crew to install the system. Self-performing this work cost about $30,000, with an additional $15,000 spent on hardware, and plant personnel are now much more familiar with the entire system because they installed it themselves.

The Productivity2000 PLC made the plant very simple to operate. The integrator took a complex process and built a control and HMI scheme for it where all the motors could be named through the HMI, with interlocks assigned in any order desired. In the past, CTC had to hardwire interlocks between conveyors, and if a downstream conveyor stopped then the upstream conveyor would stop. This wiring was time consuming and hard to change. If CTC physically changed the plant by moving conveyors and adjusting processing steps, a lot of control changes were required.

With this upgrade, CTC can now name each motor and configure what it interlocks with both upstream and downstream. Changing the position of a conveyor on the HMI changes the order of the interlocks. This activity now takes only minutes, with no re-wiring or reprogramming needed.

Author Bio

Todd Timpa is the Assistant General Manager at CTC Crushing. Originally a native of New York, he received his undergraduate degree from the University of Arizona and has remained in the Western part of the U.S. He has been with CTC Crushing for 20 years since the company's inception. He currently manages special projects for its four aggregate quarries. He's also a big fan of the Vegas Golden Knights, the local NHL hockey team, which amazingly made it to the Stanley Cup Finals in its inaugural year.

SIDEBAR: Hosted VPN

The hosted VPN solution used by CTC provides secure IIoT connectivity with simple setup and network configuration. It includes a local VPN router, a cloud-hosted VPN server and a remote VPN client. The automation system components are connected locally to the VPN router, which connects to the cloud server. The VPN client connects by laptop or PC to the cloud, and ultimately to the local automation system components (Sidebar Figure).

To accomplish this, the local VPN router makes a VPN connection to the cloud server immediately upon startup, but the VPN client only connects upon a verified request from the remote user. Once both connections have been made, all data passing through this VPN tunnel is secure.

This hosted VPN solution only required simple router configuration because the router is connected to a predefined cloud server. This allowed AutomationDirect to deliver the router preconfigured, so CTC only needed to add basic network information. The router's default firewall settings keep the plant floor network separate from the corporate network.

The VPN router includes Wi-Fi and 4G LTE connectivity options in addition to a wired LAN option. The Wi-Fi option allows the router to operate

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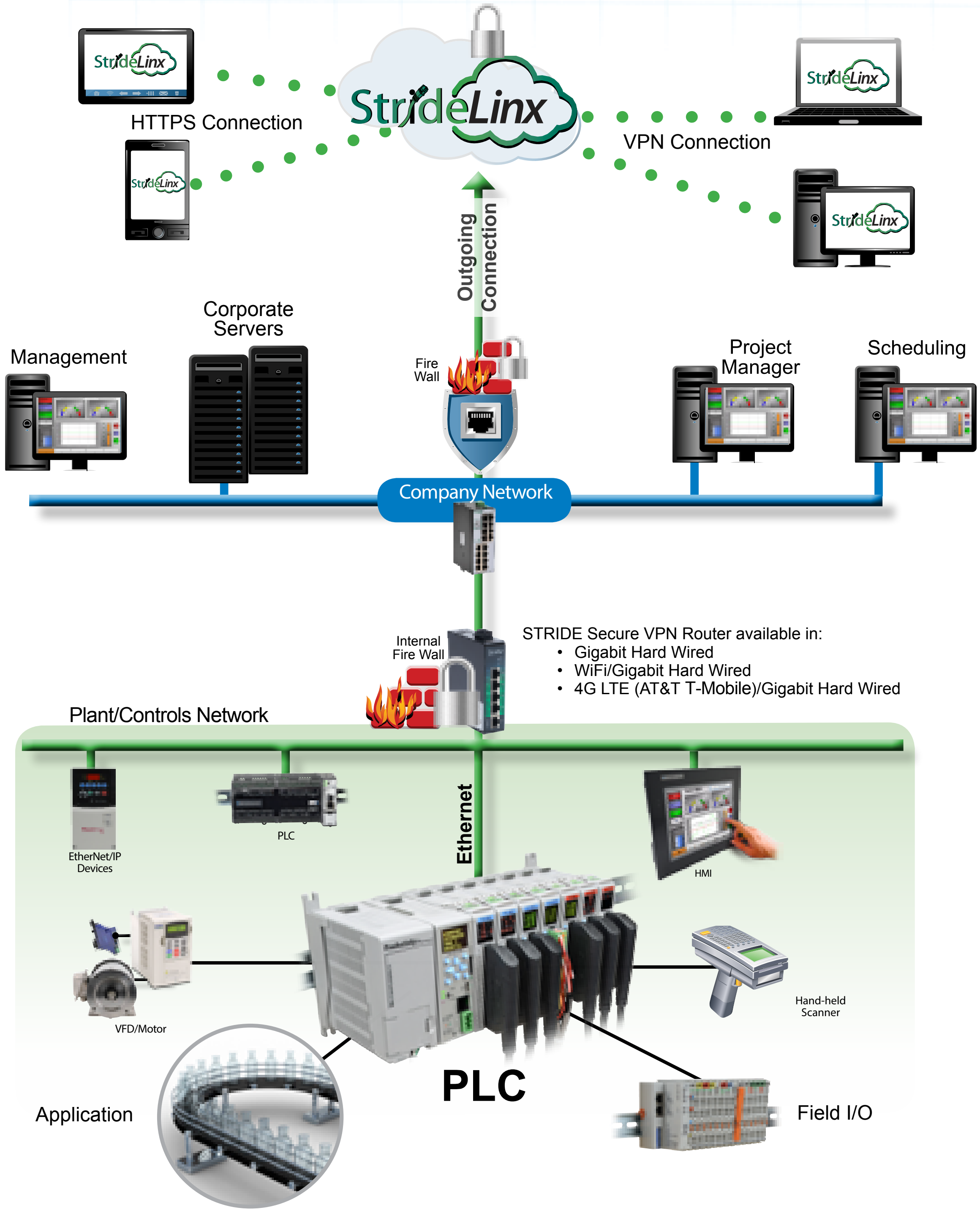


in access point or client mode. With access point mode, wireless devices connected to the router are on the LAN network, allowing plant personnel to access the control system local area network (LAN) wirelessly, rather than opening the panel to access the physical LAN connection ports. With the 4G LTE option, access can be provided from remote locations without internet access, or from locations that will not provide access to their corporate network.

Security risk is minimal with this solution because the remote client connection to the cloud server uses the robust encryption standard SSL/TLS. The required TLS key exchange, crucial for security, is done in accordance with industry standard 2048-bit RSA with SHA-256.

To further enhance security, AutomationDirect provides advanced user management, event logging and two-factor authentication. This method of authentication requires a second time-based password generated at login, providing an extra level of security.

AutomationDirect's hosted VPN solution has a free monthly bandwidth allocation for basic operation, with a premium plan offered for additional bandwidth. The free plan has proven sufficient to handle CTC's troubleshooting and programming needs.

Eastern Washington University Students Look for a Smooth Ride

Everyone likes a smooth ride in their vehicle -- unless you are off road in a 4-wheel drive vehicle. Most of us will avoid the bumps and potholes to drive on the smoothest pavement possible. Car manufacturers recognize this too. They spend lots of money on TV, print and digital advertising to promote that their vehicles have the smoothest ride on the market. It can be a major selling point when it comes to buying a car or truck.

Recently, creating the smoothest ride was the objective of a university student project where they worked together to determine what would provide a "smoother" ride. The team researched a way to keep the road smooth for auto manufacturers by using semi-active suspension rather than passive suspension.

The Senior Capstone project is a curricular requirement for all mechanical engineering students who graduate from Eastern Washington University which is located in Cheney, Washington. The project spans approximately six months where every student works in teams to conceptualize, design, and fabricate a device and/or product. This particular team consisted of six mechanical engineering students: Joe Wagoner, Gordon Henry, Jack Egan, Eric Johnson, Chandler Johnson, and Mikel Danielson. They were assisted by two mentors Dr. Matthew Michaelis and Hessam Gharavi (both EWU professors).

Two of the students became interested in the topic when they heard Professor Gharavi give an extra-curricular lecture on the subject. That interest eventually led to the idea to develop a Senior Capstone project to design and fabricate a semi-active suspension system to further analyze the dynamic response compared to passive suspension systems.

As explained in the students' project report introduction: passengers of a vehicle do not directly experience the road profile itself but rather they feel the structural response of the suspension system that transmits a particular amplitude ratio of the road to the seat of the car. The vehicle's suspension system does its best to try and diminish any bumpy movements for the passengers. Their theory was that the semi-active suspension would offer variable damping which would allow reduction in the amplitude ratio which would result in an effective increase in passenger ride comfort. The variable damping is accomplished by replacing the shock absorber with a magnetorheological (MR) damper. This variable damping from the semi-active suspension system would allow the vehicle suspension to better handle a changeable range of road excitations rather than a single frequency … meaning it would provide a smoother ride.

Given the project objective, the team developed workflows split up into subcategories to ensure all members had an active role. The team divided the work into the four phases of the engineering design process: problem scoping phase, concept generations phase, design and analysis phase, and solution implementation phase. To provide the best possible testing conditions, the team determined they should build a quarter-car test fixture frame which provided the structural support for the other assemblies and was fabricated from structural tube steel welded together. The suspension components consisted of a helical compression spring, magnetorheological (MR) damper, a secured concrete sprung mass, and sprung and unsprung mass plates. The road excitation was simulated utilizing a pneumatic cylinder actuator powered from a continued >>

compressor. Finally, the electrical assembly consisted of all sensors, controllers, pneumatic valves and electrical fixtures. The control system utilized two different types of sensors to allow for different control theories to be tested and compared between the semi-active suspension system and the passive suspension model. AutomationDirect products were part of the project including NITRA cylinders (a 4-inch diameter cylinder was used), valves, and pneumatic accessories.

Both control theories developed for the project used a specific comfort index to determine whether or not to send power to the damper per the conditional statement; thus providing for testing at varying levels. Each control method was tested by actuating the pneumatic cylinder at different amplitudes and frequencies. Both the passive and semi-active systems were analyzed at each of these amplitude/ frequency pairs. Data from these tests provided numerical results.

Results showed a measurable reduction in amplitude ratio between the semi-active and passive suspension systems. This reduction was measured using the same sensors used for the control system. Both visual and graphical results confirmed that the semi-active suspension system reduced the amplitude ratio by 5% to 20% compared to the passive suspension.

Using the semi-active suspension system, the team was able to successfully reduce the amplitude ratio felt by the sprung mass of the system. The working principle of the MR damper alone was not enough to reduce the amplitude ratio alone. It needed to be coupled with the correct control system and electrical assembly to ensure that the damper turns on and off at the correct time. While it was confirmed that the semi-active suspension system was able to successfully reduce the amplitude ratio of the system, it is unclear to what degree exactly. Several more experiments would be necessary to examine various control theories and their effects with varying amplitudes and frequencies. Ultimately, the role of the damper should be examined as well to better understand how its response plays a role in the response of the system as a whole. This project served as a great foundation in the development of a semi-active suspension test fixture.

All the students involved in this project had a background and classes in mechanical engineering and have now each earned a Bachelor of Science degree in the subject. However, that made the electrical design aspects of the project challenging at times. Fortunately, the team saw this as an opportunity and, by the project's end, had gained cross-disciplinary knowledge in the field of electrical engineering. In addition to the electrical design, the entire fabrication process was conducted by the team; therefore, all design aspects were carefully undertaken with design for manufacturability in mind. An important aspect of mechanical engineering is understanding the full product lifecycle which is critically reliant on those who fabricate the design. Manufacturing their own design gave the team insight on the difficulties of the fabrication process. Finally, during the manufacturing process, the team needed to learn new processes that they didn't have any experience with before. An example of this involved learning how to use a CNC plasma cutter and CNC milling machine.

Everyone on the team plans to pursue a career in mechanical engineering with one teammate who is interested in specializing in the control systems industry. There were many aspects of this project related to mechanical design and manufacturing that will be beneficial to all members of this project as they develop their careers. The Senior Capstone project at Eastern Washington University is designed to put students through the entire engineering design process and act as a culmination of the coursework. This project helped all members grow as engineers and the interpersonal connections made as a team will be beneficial as many of them have stayed in touch after graduation.

Sounds like a smooth road ahead for these graduates!

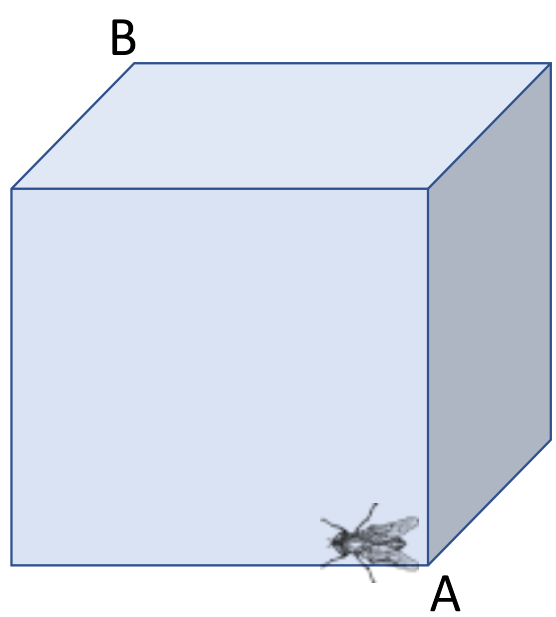
Brain Teasers

By Chip McDaniel, AutomationDirect

Pest Control

1.) The Fly's Journey

The fly can crawl completely around the base of this solid cube in four minutes. How long would it take for it to crawl from corner A to corner B?



Problem

2.) The Ant and the Honey

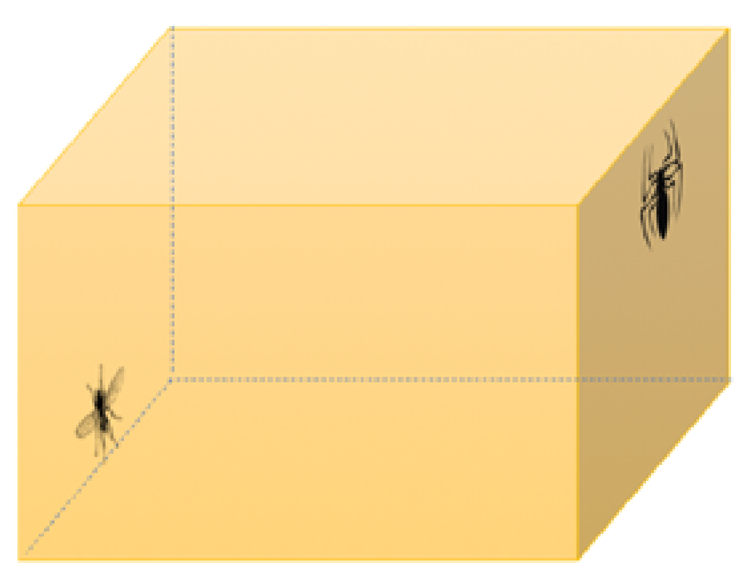
An ant is on the outside of a cylinder one inch from the bottom. There is a drop of honey 180 degrees opposite the ant, but on the inside of the cylinder, and one inch from the top. If the cylinder is four inches tall and six inches in circumference, how far will the ant have to walk to reach the honey?

3.) The Squirrel's Climb

A squirrel goes spirally up a cylindrical post, making one complete circuit in four feet (of post height). How many feet does the squirrel travel if the top of the post is sixteen feet high and three feet in circumference?

4.) The Spider and the Fly

There are a spider and a fly in a rectangular room 12 feet wide by 30 feet long, with a 12 foot ceiling. The spider is in the center of one end-wall, 1 foot from the ceiling, while the fly is in the center of the opposite end-wall, one foot from the floor. Assuming that the (oblivious) fly never moves – what is the shortest distance that the spider must crawl to catch his dinner?



Solutions on next page

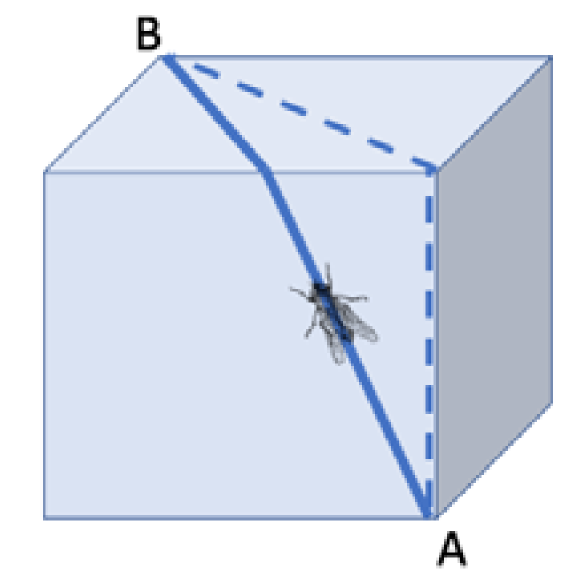
Brain Teaser Answers

By Chip McDaniel, AutomationDirect

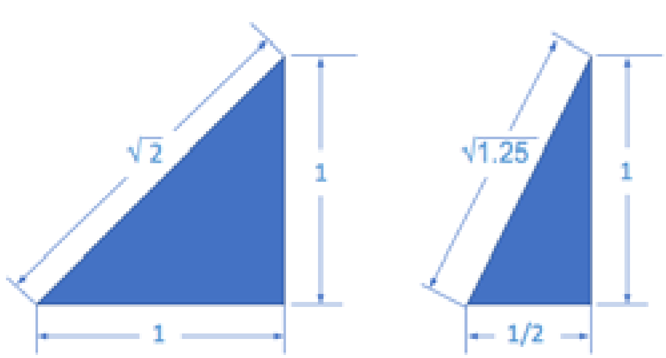
Pest Control

1.) The Fly's Journey Solution

While the run-of-the-mill house fly might follow the path indicated by the dotted line below, it would need 2.41 minutes (1 + sq. root 2) to reach B. The clever fly would take the more direct (solid line) path, and reach B in 2.236 minutes (2 * sq. root 1.25)

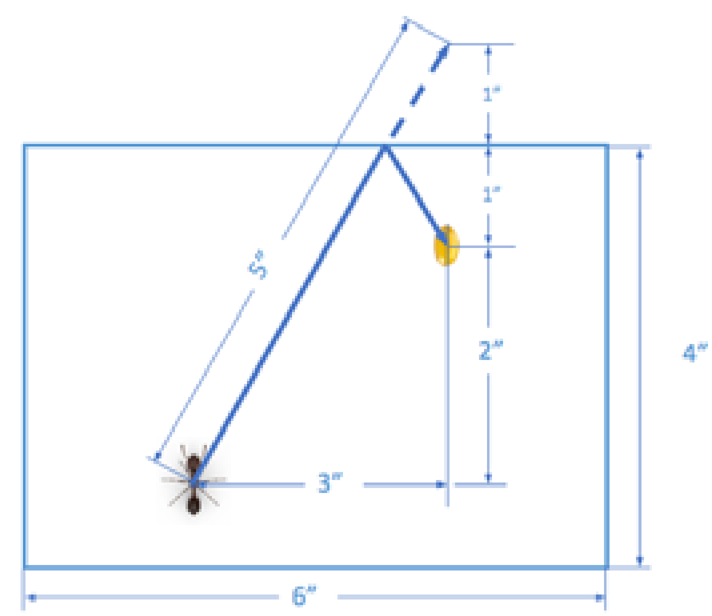


Solution



2.) The Ant and the Honey Solution

It may help to "unroll" the cylinder as a mental exercise. And note that the "crossing over" of the upper edge of the cylinder can be "flipped" so that the entire path is represented by a straight line. The distance can then be calculated with a simple Pythagorean triangle. A right triangle with sides of 3" and 4" has a hypotenuse 5" in length. The ant would need to walk 5" to reach the honey.



3.) The Squirrel's Climb

Similar to the previous puzzle – "unwrapping" the cylinder may help simplify the calculation. To make one revolution, the squirrel is climbing along the hypotenuse of a right triangle with sides of three feet and four feet in this case – for a total of 5 feet of travel per rev. To climb a pole sixteen feet tall, the squirrel must make four revolutions, and travel a total of twenty feet.

continued >>

Brain Teaser Answers

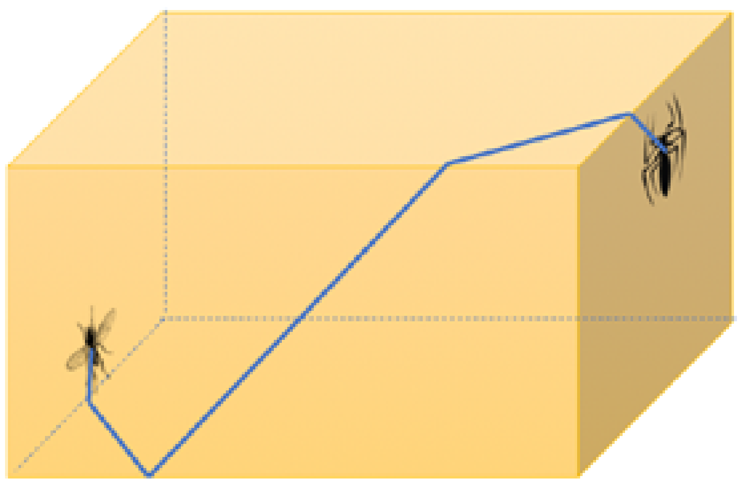
By Chip McDaniel, AutomationDirect

Pest Control

4.) The Spider and the Fly

There are a couple of answers to this one.

If the spider takes a direct path (parallel to the side walls), it would go up one foot, along the ceiling for 30 feet, and then 11 feet down the far wall, for a trip distance of 42 feet.



However, if the Spider is to crawl for the entire trip, the shortest path is shown here: