Legalities 10 | Double the cybersecurity 14

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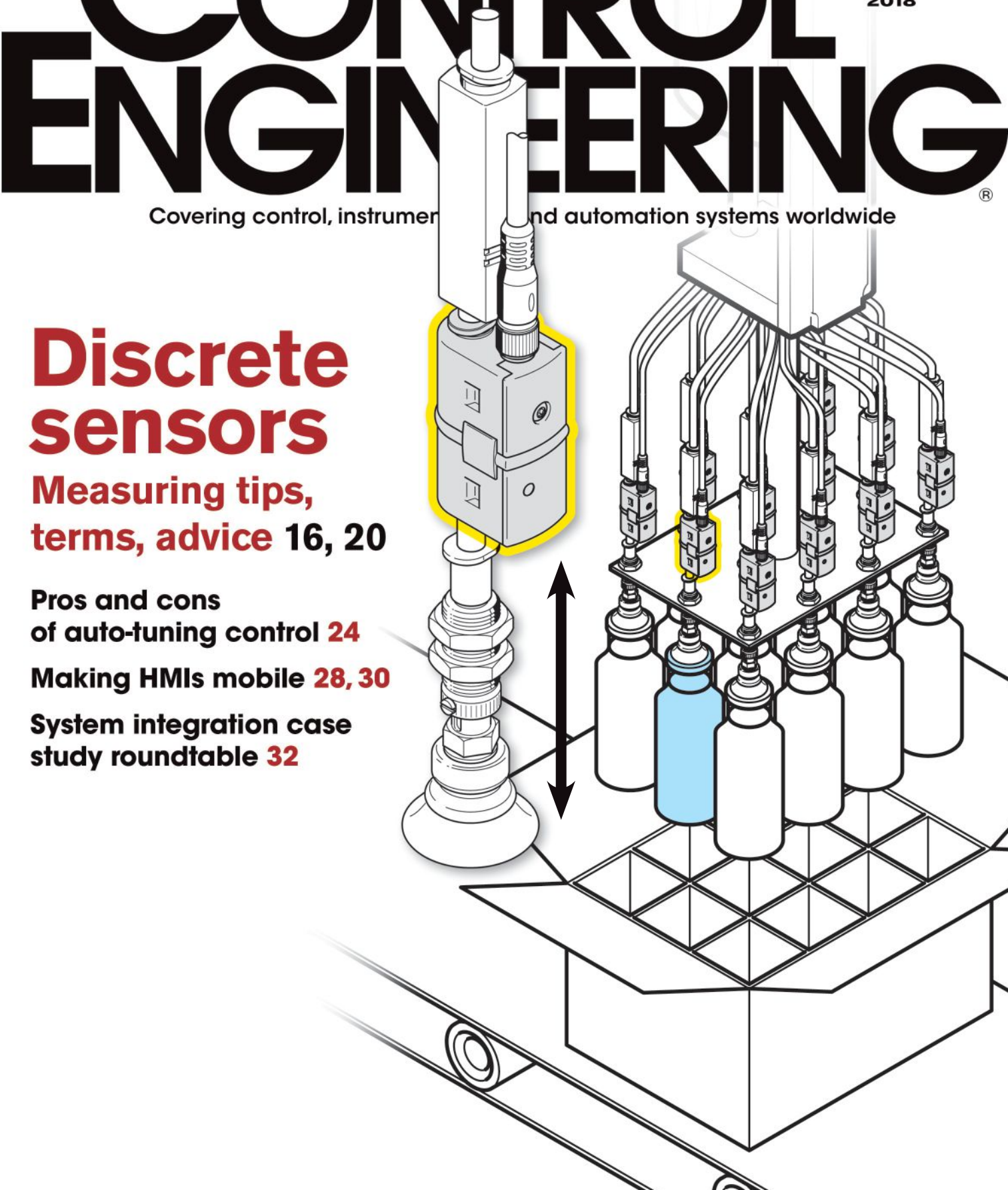

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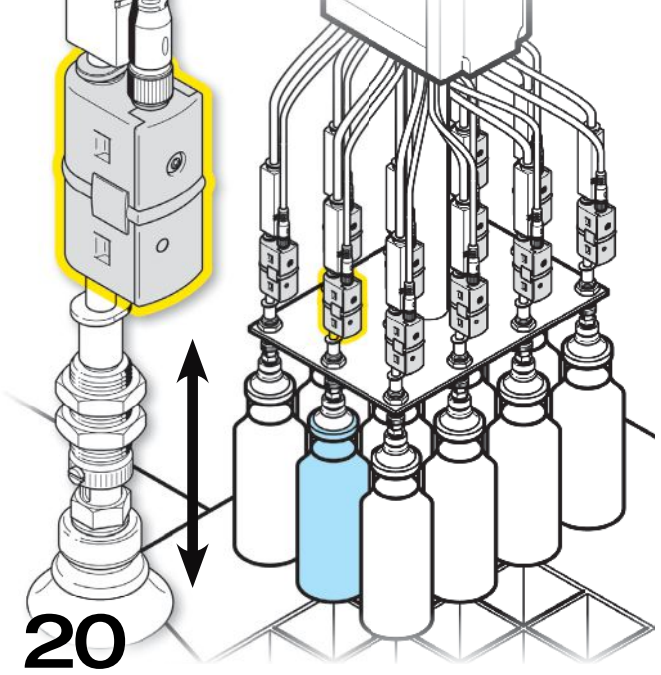

20

COVER IMAGE: Presence control, usually considered discrete sensing, can be achieved with a pressure or vacuum sensor, often considered a process sensor. Courtesy: Festo

CONTROL ENGINEERING

Vol. 65
Number 6

JUNE 2018

INSIGHTS

ONLINE

- **Four control system benefits for mobile machinery:** *Wade Wessler and Chris Vrettacos, Cross Co.*
- **Replacing stationary HMI with contextual HMIs:** *Ed Nugent, PcVue Inc.*
- **Digital twin AIs designed to learn at the edge:** *Chris Middleton, Vinelake*
- **China's robotics market is poised for rapid expansion:** *Jessica Twentyman, Vinelake*

ANSWERS

INNOVATIONS

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Mark T. Hoske and Amanda Pelliccione, *Control Engineering*

Control engineers' job concerns

Economy, time and resources, career, education, and company leaders were the most-cited concerns for respondents to the *Control Engineering* Career and Salary Report survey in 2018.

What keeps you up at night? That's a common question among peers, and the 2018 *Control Engineering* Career and Salary Report survey asked respondents about their job-related concerns. Respondents offered 154 answers to the fill-in question asking about job-related concerns in the next 12 months. Most-cited concerns were economy and business, time and resources, my career, education, and company leaders were the most-cited concerns.

Replies were subjectively divided into nine categories created after the survey, based on the response. Where multiple concerns were offered, one category was chosen. A sampling of the advice, divided into nine categories, and lightly edited for clarity, follows.

Concern: Economy, business

A weakening economy and unstable stock market.
Attracting client interest in information technology (IT) and system integration.
Economy of our industry. Performance of sales personnel. Replacing an employee if one is lost.
Further economic pressures from globalization, lower quality competition accepted in the marketplace
Growth.
Increasing sales.
Make money for the company.
Market stability.
Must have sales, bottom line.
Time to market for new products.

Concern: Time, resources

Ability to continue working and increasing workload.
Accomplishing all of my yearly goals with limited time and resources.
Being compensated for the job done and not being shortchanged because I'm younger.
Finishing project before deadline.
Implementing numerous new procedures into operations without proper tools and support.
Implementing projects.
Increased job load without increasing head count.
Keeping machines running.

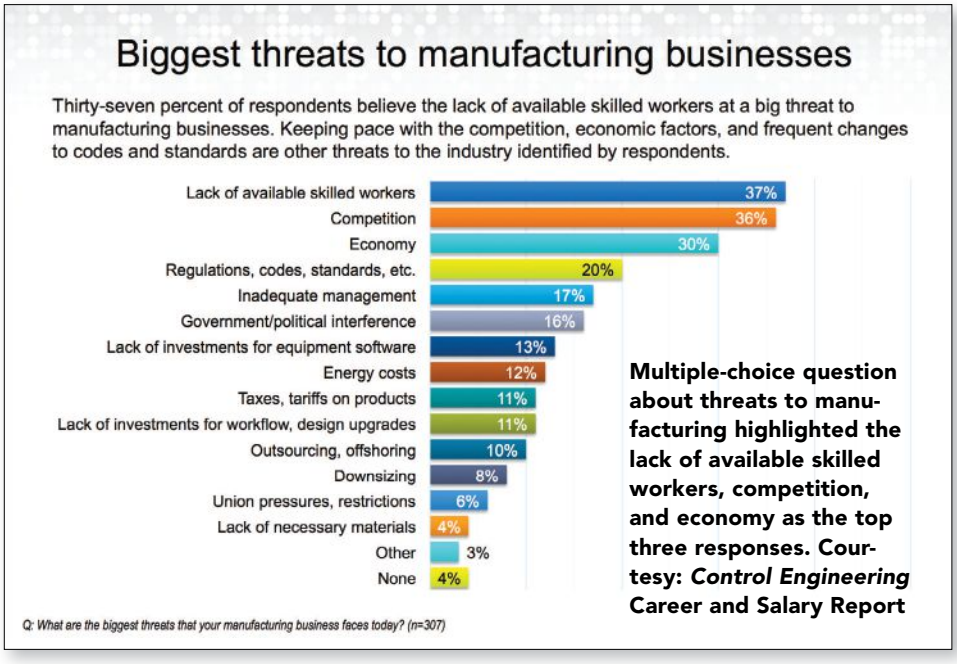
Concern: My career

Facing retirement soon.
Finding a more attractive and challenging position.
Too much outsourcing in the IT space.
Upward mobility.
Unkept promises, organization politics, and getting what I deserve.

Concern: Education

Lack of time for training on deploying new systems.
How to maintain new equipment.
Staying current on technical advancements.
To learn the new control system.

Percent	Write-in concern (#)
18%	Economy, business (27)
16%	Time, resources (24)
15%	My career (23)
13%	Education (20)
11%	Company leaders (17)
9%	Upgrades (14)
7%	Safety, quality (11)
6%	Hiring, retaining talent (10)
5%	Government (8)



Multiple-choice question about threats to manufacturing highlighted the lack of available skilled workers, competition, and economy as the top three responses. Courtesy: *Control Engineering* Career and Salary Report

Training on Industrial Internet of Things (IIoT), cybersecurity, operational technology (OT) risk management.

Concern: Company leaders

Changing market.
Mismanagement by the managers.
Moral in the engineering office. We are blamed for everything.
Working around bean counter delays.

Concern: Upgrades

Adequate investment in upgrades.
Automation of current jobs via Internet of Things. (IoT)
Being able to keep up with competitor's advances in launching innovative products.
Changing technology.
Machine integration.
Technologies in use are not digital, so we require training.

Concern: Safety, quality

Build quality.
Evaluation of safety and reliability.
Hoping the company maintains quality so work remains.
IoT security.
Worker safety is number one.

Concern: Hiring, retention

Finding talented employees and employees willing to work.
Having the resources (personnel and assets) to initiate new opportunities for process improvement.
I am concerned that we are losing talent and cannot replace it. This puts more on those left and degrades quality.
Lack of succession plan. We are losing the wisdom talent of retiring staff at an alarming rate with very little in place to address it.

Concern: Government

Administration.
Elimination of clients by unreasonable environmental and governmental pressure.
Fixing offshoring issues.
Market changes, unpredictable federal governance. **ce**

Edited by ***Mark T. Hoske,*** *content manager,* Control Engineering, *CFE Media, mhoske@cfemedia.com. Data provided by CFE Media research director,* ***Amanda Pelliccione,*** *apelliccione@cfemedia.com.*

More INSIGHTS

KEYWORDS: **Salary survey, manufacturing**

More Career and Salary Report 2018.

Respondents listed their concerns.

Greatest concerns: Economy and business, time, and resources.

CONSIDER THIS

See other tools and strategies in this issue of *Control Engineering* to help make better use of one of your biggest concerns.

ONLINE

If reading from the digital edition, click on the headline to link to other Career Update resources from the May 2018 issue or go to www.controleng.com/CE-research.

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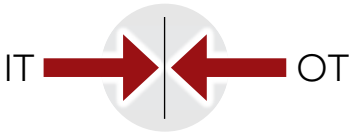

Finding common ground for IT/OT convergence

Finding a common understanding between information technology (IT) and operations technology (OT) means avoiding a lot of issues with overall facility operations.

The traditional definitions of information technology (IT) and operations technology (OT) need to be explored and revised to allow these two groups to work together, not against each other. A lot of common ground between IT and OT needs to be understood to optimize operations and to further understand the need for IT/OT convergence.

IT personnel may be associated with minor computer issues, however one of their most important jobs is to maintain security for networks and devices. OT is responsible for keeping the plant, machines, and manufacturing processes running reliably and efficiently.

Conflicts between IT and OT

When conflicts occur between IT and OT, it is often due to competing priorities of security versus efficiency and uptime. For example, to maintain computer security, IT needs to update and patch operating systems. However, this may cause someone in OT to be apprehensive. An update could "break" specialized controls software, resulting in machine shutdowns or some other unintended negative effect. It is not to say OT also doesn't have cybersecurity concerns. A security approach often taken by OT is to isolate computers and other devices onto a standalone network and physically restrict access to the network and devices.

Conflicts also can arise with access control and networking. If an issue with a machine process occurs, someone from OT may need to quickly connect to the network to troubleshoot the issue to get the process running again.

Common ground for IT, OT

While the two priorities of security and uptime may seem at odds, there is room for common ground. Several high-profile cases have demonstrated computer viruses have the potential to impact control systems and can be transmitted by a USB drive or laptop, not just over the internet. Also, through the networking of controls equipment with the business side of the network data can be collected and analyzed to provide powerful feedback.

A takeaway for OT is it is not necessarily efficient or secure to simply isolate controls equipment on its own network. However, a takeaway for IT is many of the procedures and practices that are geared for devices found on the business side of the network can cause issues for control systems.

What this means is that IT and OT professionals must find common ground. IT professionals need to understand OT and devices such as PLCs, HMIs, VFDs, and supervisory control and data acquisition (SCADA) software. OT professionals need to understand networking, security, and be capable of configuring equipment.

The same point can be made about the network architecture. OT devices should not be added to the IT network. It's also not necessarily a good practice just to put OT equipment on its own isolated network. There needs to be a level of separation, but also an overlap between the IT and OT network. There are practical ways to do this such as creating industrial demilitarized zones by using industrial-rated routers and firewalls. Many security devices are designed specifically for control systems. These devices rely on standards and best practices already followed in IT but are designed with OT in mind.

Better defining IT and OT makes it easier to see they are not separate disciplines and the traditional definitions may need to be reconsidered. Some have referred to this trend as the "IT/OT convergence." The line between OT and IT is becoming more blurred, and they will need to work together in the future. **ce**

Nate Kay *is a project manager, MartinCSI. Edited by Emily Guenther, associate content manager,* Control Engineering, *CFE Media, eguenther@cfemedia.com.*

More ANSWERS

KEYWORDS: information technology (IT) and operations technology (OT)

Traditional definitions of IT and OT

Understanding the roles of IT and OT

The convergence of IT and OT operations.

CONSIDER THIS

How can IT and OT converge to optimize your facility's operations?

ONLINE

Read more online about the conflicts between IT and OT.

See related articles and the IIoT page on www.controleng.com.

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Mark Voigtmann and Brian Clifford, Faegre Baker Daniels LLP

Untangle indemnification clauses

What does it mean to indemnify an automation project customer or control system integrator?

Nearly every automation contract has at least one provision that says the system integrator will "indemnify" the customer or end user. What exactly does this mean for the risk the integrator is undertaking for the project?

Despite all the legal jargon in these provisions, the concept of indemnification at its core is simple. Through these provisions, the integrator agrees to pay a debt of the customer. If the customer has a claim or legal action filed against it and the alleged damages fall under the indemnification provision, the integrator is agrees to "step into the shoes" of the customer when it comes to financial responsibility.

For example, if the integrator negligently implemented a control system that ended up injuring someone, whenever that someone goes after the customer, the integrator promises to take responsibility for that injury.

Turning indemnification sideways

However, indemnity can turn sideways and upsidedown in several ways.

Unconnected to fault. Some indemnification provisions are far too broad and encompass items for which the integrator should not be held responsible. It's crucial to know the difference between what is reasonable and unreasonable.

It's reasonable that the implementer takes responsibility for a bodily injury or property damage claim that is made against its customer "to the extent" the claim is the result of the integrator's own negligence. (Plus, the integrator's commercial general liability insurance coverage generally provides protection from this risk.) It's also reasonable for the integrator to indemnify the customer from intellectual property claims that arise from infringing material the integrator created.

What is unreasonable is an indemnification provision that makes the integrator responsible for all damages in any way related to the project, even if the loss is caused by the customer's own negligence. Such a provision is unfair and uninsurable, and in some states may be illegal. A requirement that the integrator pay for patent infringement damages, even when the problem is with commercial-off-the-shelf hardware or software the integrator provided as part of its work, also can lead to a very large pay-out for a risk over which the integrator had no control.

Beyond third-party claims. Another category of "overreaching" with indemnification provisions is when the customer or end user bends them beyond the reasonable goal of protecting the customer from the claims of others to making them a source of potential claims by the customer itself. This practice can poke a hole in the insurance umbrella (commercial general liability policies typically do not cover first-party contract disputes), and may make an indemnity clause a place to hide nasty legal time bombs—such as a requirement that the integrator pay for the customer's attorneys no matter the source of the dispute.

Companion terms. A third category: Rarely does one see the word "indemnify" without the companion phrases "hold harmless and defend."

These expand the obligation. Between the two, the word "defend" creates the most risk. It means that in addition to the integrator taking responsibility for claims made against its customer, the integrator will be hiring a lawyer to represent and go to court for the customer. This can make the smallest dispute an expensive outing.

With the "hold harmless" term, the integrator is promising the customer it will not file a lawsuit that seeks to hold the customer responsible for a particular category of injuries or damage. That promise is reasonable but only to the extent the injury or damage was caused by the integrator.

Both directions

The good news is indemnification provisions can work both ways and can (and often should) be used to require the parties to indemnify each other. An important indemnification provision for integrators to consider including is one requiring the customer to indemnify the integrator from any claims for damages arising from the customer's failure to maintain the health and safety of its facility and equipment, or for any claims arising from pre-existing conditions of the facility and equipment.

A good rule of thumb for integrators: indemnify for third-party injuries and damage that you cause and can control (and, ideally, which can be insured). Try to refrain from indemnifying for anything else. **ce**

Mark Voigtmann and Brian Clifford *are partners in the automation and robotics practice of Faegre Baker Daniels LLP, a law firm in the U.S., U.K., and China. Voigtmann is on the* Control Engineering *Editorial Advisory Board. Edited by Mark T. Hoske, content manager,* Control Engineering, *mhoske@cfemedia.com.*

More INSIGHTS

KEYWORDS: indemnification

Indemnification can add contract complexity.

Both parties can hold the other responsible.

CONSIDER THIS

Are you examining contracts for indemnification clauses?

ONLINE

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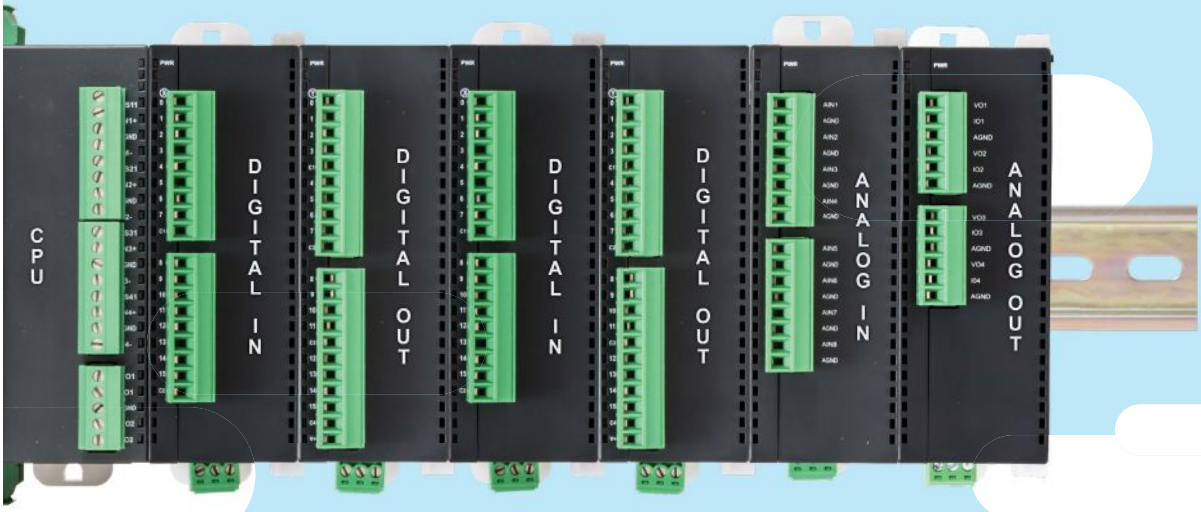

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Drones get a virtual-reality testing ground

MIT engineers have developed a virtual-reality training system designed to enable a drone to "see" a virtual environment while flying in an empty physical space. The "Flight Goggles" system operates as a virtual testbed for environments and conditions in which researchers might want to train fast-flying drones.

MIT engineers have developed a new virtual-reality training system for drones. Courtesy: William Litant, MIT

"We think this is a game-changer in the development of drone technology, for drones that go fast," said Sertac Karaman, associate professor of aeronautics and astronautics at MIT. "If anything, the system can make autonomous vehicles more responsive, faster, and more efficient."

Pushing boundaries

At present, training autonomous drones is a physical task: researchers fly drones in large, enclosed testing grounds, in which they often hang large nets to catch any careening vehicles. They set up windows and doors through which a drone can learn to fly.

When vehicles crash, they must be repaired or replaced, which delays development and adds cost.

The team's virtual training system comprises a motion capture system, an image rendering program, and electronics that enable the team to quickly process images and transmit them to the drone.

The test space (a hangar-like gymnasium in MIT's new drone-testing facility) is lined with motion-capture cameras that track the orientation of the drone as it's flying.

As the drone flew through this virtual room, the researchers tuned a navigation algorithm, enabling the drone to learn on the fly. During 10 flights, the drone—flying at around 2.3 meters per second (5 mph)—successfully flew through the virtual window 361 times, and only "crashed" the window three times.

***Jennifer Chu** is with MIT News Office. Edited by Chris Vavra, production editor,* Control Engineering, *cvavra@cfemedia.com.*

System integrator honors

Almost 600 system integration industry professionals from 16 countries attended the Control System Integrators Association (CSIA) Executive Conference in San Francisco, April 24-27. A two-day workshop was held before the conference on the CSIA's Best Practices and Benchmarking manual, which helps with CSIA certification.

CSIA gave awards to five organizations and individuals:

- A&E Engineering, Greer, S.C., was named 2018 Integrator Company Member of the Year.
- Mitsubishi Electric Automation, Vernon Hills, Ill., was recognized as 2018 Partner Company Member of the Year.
- The 2018 Rising Star award was presented to John Binion, PE, Hargrove Controls + Automation, Mobile, Ala.
- Social Responsibility Award: MR Systems, Norcross, Ga.
- Luigi De Bernardini, Autoware, S.R.L., Vicenza, Italy, received the 2018 Charlie Bergman "Remember Me" Award.

The award is named after CSIA's founder and visionary, and remains the highest distinction for CSIA members.

Next Executive Conference is April 30-May 3, Asheville, N.C.

Edited from a CSIA press release by CFE Media. CSIA is a CFE Media content partner.

Luigi De Bernardini, Autoware, S.R.L., Vicenza, Italy, received the 2018 Charlie Bergman Award, which recognizes a member for upholding the principles of sharing, leadership, and promoting the profession. Courtesy: CSIA

Headlines online

Top *Control Engineering* articles, May 14-20
Salary Survey, IIoT and sensors, career advice, industrial analytics.

Cybersecurity education outreach pact reached
Florida International University will help the National Institute of Standards and Technology build cybersecurity education, training.

PMI slips in April over labor concerns
The Purchasing Manufacturers' Index from the Institute for Supply Management fell 2.0 percentage points in April to a robust 57.3%; manufacturers struggle to find employees to meet high demand.

Electrical connection company completes separation
nVent Electric plc separated from Pentair plc.

Smarter manufacturing with ESI software
BAE Systems selected Tapestry Solutions to help automate.

North American robot sales break record to start 2018
RIA: Record shipments to N. American companies in 1Q18

Manufacturer purchased pneumatics company
Emerson agreed on terms to acquire Aventics from Triton.

Double cybersecurity

Convergence of cybersecurity efforts from operational and information technology specialists creates extra interest, investments.

Cybersecurity interest at company's board level is helping to create discussions, convergence, and collaboration of efforts from operations technology (OT) and information technology (IT) specialists. While spending continues to increase to upgrade technologies and behaviors to combat cybersecurity threats, there is no cure-all answer. These were the views of Walter Sikora, division manager, cyber security services, ABB industrial automation division, in a discussion with CFE Media at ARC Forum in February. His thoughts follow.

Mark T. Hoske, Content Manager

Cyberawareness

OT personnel, including those with automation and controls responsibilities, are getting smarter about cybersecurity risks and why they need to protect operational assets. However, many organizations still lack the maturity level required to use effectively advance security technologies such as network anomaly detection or purchasing a subscription to indicators of compromise.

Most OT personnel should focus attention to the basics such as perimeter access controls, segmentation, system hardening, security patching, endpoint security, and malware protection along with periodic assessments and awareness training.

In process industries, it's impossible to have a safe and reliable system without giving serious attention to cybersecurity. In the past few years, more attention has resulted in measuring the number of incidents and sharing information.

For example, Sikora said, one company CEO who suffered a June 2017 cyberattack, shared that 10 days of production losses cost more than $200 million; recovery required purchase, and configuration of 45,000 new computers in 10 days.

Automation vendors can help customers understand and mitigate risks and sustain production by offering related cybersecurity services to help prevent attacks from impacting operations. Operation personnel can calculate the return on investment of these services if they consider the cost of a cyberattack on their operations if they take no measures to protect their assets.

Cybersecurity education

Educating the organization on cyber risks is key, especially since many hackers still gain access through phishing schemes. Also, the notion of system isolation no longer apply; as systems running on 10-to-15-year-old software often are vulnerable to exploits that can be transferred by way of mobile devices like USB keys, laptops, or an operator who wants to charge a cell phone by plugging into a workstation.

Think again about helping others in your organization understand cybersecurity risks and mitigations.

Equally important is educating IT personnel, who often lack detailed knowledge of plant-floor intricacies but can provide discipline and offer valuable assistance regarding change management and criticality of mitigation actions. With a side of healthy paranoia, they can benefit from learning how operation systems function.

Those serious about addressing risk can use key performance indicators related to security. Iin many cases, organizations are insecure when best practices are not properly implement or continuously sustained. OT personnel have been developing a better understanding of the complexity of security concepts and how to implement cyber protection of production systems but still need to collaborate with operational system suppliers. **ce**

More INSIGHTS

If reading from the digital edition, click on the headline for more cybersecurity resources.

www.controleng.com/magazine

www.controleng.com covers cybersecurity and networking topics.

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* If the content meets criteria noted in guidelines, expect to see it first on our Websites. Content for our e-newsletters comes from content already available on our Websites. All content for print also will be online. All content that appears in our print magazines will appear as space permits, and we will indicate in print if more content from that article is available online.

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Jon Breen, Breen Machine Automation Services LLC

Discrete sensors 101: Sensor types and best practices

Measuring success: Understand which type of discrete sensors to use for what applications, plus terminology and tips.

Discrete or digital sensing is ubiquitous in automation. It has been used since the days of relay logic, before programmable logic controllers (PLCs) even existed, and its use today continues to simplify logic in the PLC. A discrete sensor sends an on/off (yes/no) signal, often allowing the PLC to ignore analog threshold, deadband, detection speed, and other complexities.

That signal could mean "I see a part," "machine air pressure is above 80 psi," "actuator has reached position," "heater at temperature," or a number of other situations. Robust machine function is highly dependent on using the right sensors in the right ways. Each one of these conditions is likely to use a different type of sensor.

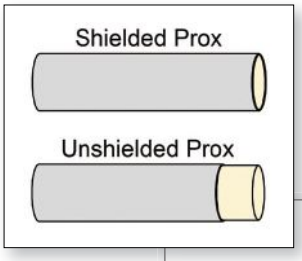

Figure 1: Shielded versus unshielded prox switches. Notice the extra yellow plastic visible on the unshielded version. All graphics courtesy: Breen Machine Automation Services LLC

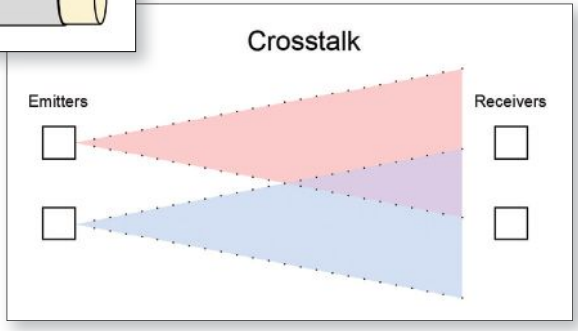

Figure 2: Photo eyes interfering with each other.

Common types of sensors

Below are many common types of sensors used for automation.

Limit switches

Limit switches, which are still in use today, have a mechanical switch that's turned on or off when it's in contact with a part. They can be found in various shapes and sizes and offer options like redundant contacts. Despite their simplicity and availability, many applications have transitioned to non-contact, solid-state sensors for their flexibility and long life. It also can be an inconvenience that limit switches require contact with the part they sense.

Reed switches

Reed switches, which are mostly used in pneumatics have a mechanical switch that's turned on/off by a magnet. These are typically mounted on the cylinder where the piston has a magnet in it. Note that it's not always best practice to sense the cylinder position. For example, when a cylinder drives a linkage that drives a plate which pushes a part into position. What if the pin comes out of the linkage? What if the linkage has some "slop" or backlash in its motion? It's better to sense the plate that touches the part, rather than sensing the position of the cylinder. Since these are mechanical devices, there's the same question of longevity as with limit switches. There are solid state versions of cylinder switches that can be used instead.

Proximity switches

Proximity switches are another common sensor that usually operates on an inductive principle, which requires metal—preferably containing iron—to function. Non-ferrous metals such as aluminum and copper can also be used, but these metals don't detect as well as iron. In this case, there would be a shorter sensing range, and require a larger target to sense at all (sometimes to the point where it's not very useful). There are two ways to improve detection in this case:

More ANSWERS

KEYWORDS: discrete sensors, programmable logic controller

Explore the main uses for discrete sensors.

Recognize common discrete sensor types by category.

Learn best practices and pitfalls to avoid with discrete sensors.

CONSIDER THIS

What type of sensor would make the most sense for your application?

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1. Put a steel screw in the non-ferrous target for the prox to see.

2. Use a "long-range" or "unshielded" prox. These are two names for a prox that is more sensitive because it has less metal shrouding on the tip of the sensor.

Other varieties that function on non-inductive principles (capacitive and ultrasonic) and can sense non-metallic parts do exist. However, this is unusual enough that when a proximity switch comes up in conversation, it's usually assumed to be inductive.

Key terms and application notes for photo-eye (PE) sensors

- **Visible versus infrared (IR) light:** Users will usually have to aim the light, and that's a lot easier if it can be seen, so consider visible light unless there's a reason to use infrared (IR).
- **Crosstalk:** The light from these sensors can interfere with other sensors and light curtains. Consider that the light won't be a line, it'll be a cone and may affect other devices that use the same wavelength (Figure 2).

Several strategies can help combat crosstalk:

- **Alternate light direction** when PEs are close to each other. For example, where two PEs are measuring across a conveyor 6-in. apart, the first one has its emitter on the left side, the second on the right.
- **Use different light wavelengths.** For example, light curtains typically use infrared light. If PEs are used near a light curtain, use visible light PEs.
- **Put apertures** on the emitters to narrow the cone of light.
- **Light-on versus dark-on:** Should the sensor be on when it sees light, or when it doesn't see light? This is usually adjustable with a screwdriver or button.
- **Precision:** Simple PE applications don't give very precise locations of the object being sensed. For example, sensing boxes on a conveyor with a reflective PE may only be accurate within an inch or two. Using fiber optic lines or apertures to make the emitted light and receiving area both as small as possible can help improve accuracy.
- **Lasers:** These cost more but can do things other sensors can't such as detect distance rather than only light blocking/reflecting. They also sense clear parts, like plastic or glass.

Photoelectric or photo eye sensors

Photo eye (PE) sensors have a light "emitter" and "receiver." Sometimes they're in the same package, or separate. These are usually an inexpensive way to track parts in a system. Sometimes light is guided through fiber optic lines or it's used directly from the emitter/receiver. Parts can be detected either by reflecting light back to the receiver (a reflective application) or by blocking the light beam from reaching the receiver (a through-beam application).

Choosing a type of sensor

When purchasing a sensor, there are many options. Once a sensor is chosen that fits mechanically and is the general type, there are other considerations to consider during the selection process:

- **PNP versus NPN**: This is a required option for all solid-state devices. It describes the direction of current flow. PNP is typical in the U.S., but if there's equipment from other origins, it's important to know what the PLC input is expecting. If the PLC manual says "sinking input," it's PNP; if it says "sourcing input," it's NPN. Some input modules can be configured as either. In that case, look at what's connected to the "common" terminal. If the common terminal is 0 V dc, it's PNP; 24 V dc is NPN.
- **2-wire versus 3-wire**: This is mostly a choice between a mechanical contact (2-wire) and a solid-state contact (3-wire).
- **Quick disconnect versus integrated cable**: Many sensors offer the option to have a permanently connected cable or a quick disconnect. For a slightly higher cost, the quick disconnect option usually makes maintenance a lot easier. If the sensor breaks, a new cable isn't necessary.

There was a time when discrete sensors were truly digital in nature such as a mechanical pressure switch using a spring-loaded diaphragm, or a mercury-based thermostat, but the line is blurring. Modern discrete sensors often measure things such as pressure, temperature, inductance, and brightness in analog and convert to a digital yes or no using a tiny computer. Remarkably, many simple sensors now can pass that analog information back to the PLC using technologies like IO-Link (IO-Link Consortium). If the data exists, and there's a computer in there already, why not take advantage of it? This is a relatively new trend and hasn't yet found a strong foothold in the market. The PLC and ladder logic programming language were founded on the concept of discrete signals. **ce**

Jon Breen *is the owner at Breen Machine Automation Services LLC. Edited by Emily Guenther, associate content manager,* Control Engineering, *CFE Media, eguenther@cfemedia.com.*

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Sandro Quintero, Festo

Tips on sensor selection

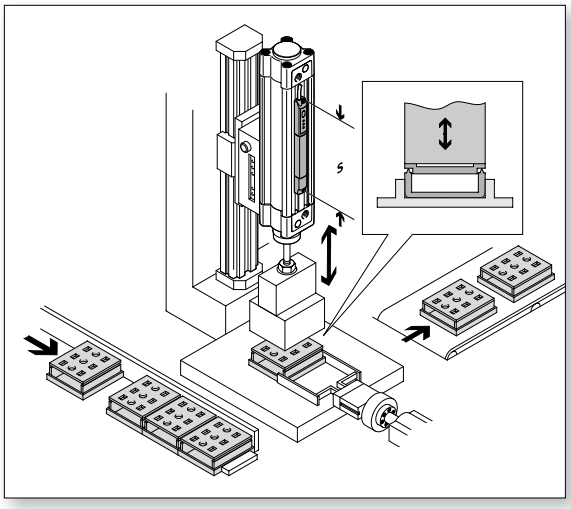
Different sensors can help manufacturers and machine designers; implementations improve by knowing the application and operating conditions.

At the beginning of my engineering career, a sales engineer from a sensor company came to our plant, thumped a substantial and well-worn sample case down on our conference room table, flipped the case open to expose dozens of neatly packed sensors and said, "Let's test your part."

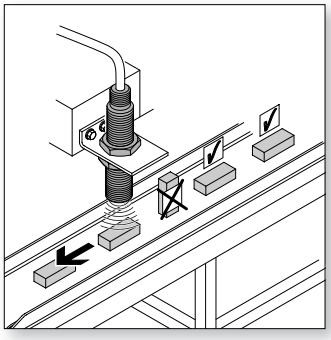
He knew what he was talking about. Engineers must test the sensor with the part. Locating the right sensor for the application requires narrowing the search to a short list of sensors; ordering samples, and testing the sensor with the part, the actuator, or the machine under conditions similar to where the sensor will be installed.

When identifying sensors to sample, ensure the set—based on the manufacturer's data sheet—meets the basic operating conditions of the application. Six leading operating condition requirements are: 1) Temperature range 2) Size 3) Protection class 4) Voltage range 5) Discrete or analog output 6) Parameter change, that is, "Will it be beneficial to be able to change parameters?" If the answer is yes, then a sensor with IO-Link (IO-Link Consortium) should be considered. Six more considerations are: 1) Response speed 2) Sensing range 3) Repetition accuracy 4) Electrical connection 5) Mounting type 6) Visual display: Is an on-sensor visual display required for the application?

Below, see the six most common sensor types used in manufacturing with tips and insights.



A magnet proximity sensor can detect an actuator's position. All illustrations courtesy: Festo



Analog inductive sensors can be used to measure position.

1. Proximity sensors

A proximity sensor detects the presence of nearby objects without physical contact. Presence sensors are discrete output devices. Typically, a magnetic proximity sensor is used to detect when an actuator reaches a specific position by sensing a magnet located in the actuator.

It is not a good idea to purchase actuators from one company and magnetic proximity sensors from another. While the sensor manufacturer may say the sensor is compatible with X, Y, and Z actuators, the reality is variations in magnets and mounting positions can cause sensing issues. For example, the sensor may activate when the magnet is not in the correct position or it may not activate at all. If the manufacturer of the actuator offers a matched proximity sensor, it should be the first-choice sensor.

Transistor-based proximity sensors have no moving parts and long service lives. Reed-based proximity sensors use a mechanical contact, have shorter service lives, and cost less than transistor models. Reed sensors are best applied in high-temperature applications and applications where ac power supply is needed.

2. Position sensors

Position sensors have analog outputs indicating the position of the actuator based on the position of the magnet on that actuator. Position sensors provide flexibility from a control standpoint. The control engineer can determine a range of set points to conform to component variations.

Since these position sensors are based on magnets,

More ANSWERS

KEYWORDS: process sensors, discrete sensors

Locating the right sensor for the application requires testing.

Heed sensor selection criteria.

ONLINE

Read this article online at www.controleng.com for additional information about sensor types including vision sensors, signal converters, and flow sensors.

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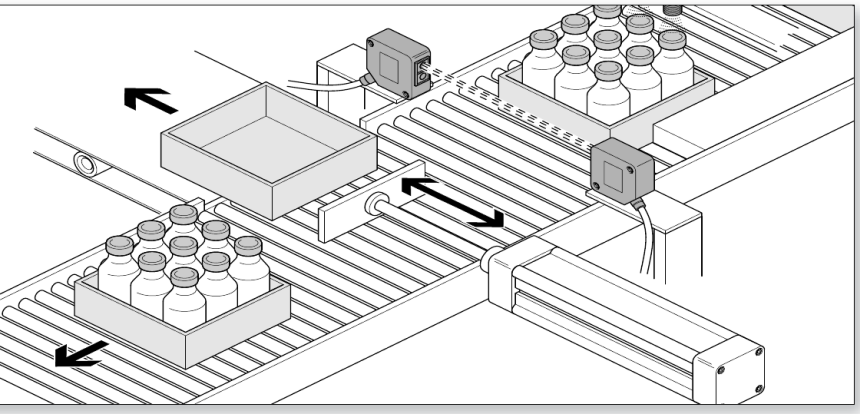
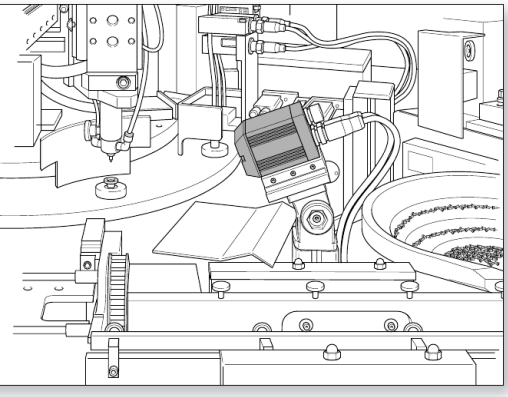
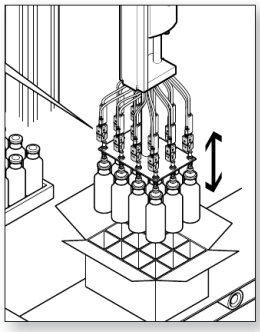


A photoelectric sensor detects the presence of an object via reflected light or interrupted beam of light.



For type, position, and rotary orientation detection, an intelligent compact vision system is ideal.



COVER PHOTO: Presence control can be achieved with a pressure or vacuum sensor.

like proximity sensors, it's a good idea to purchase the sensor and actuator from the same manufacturer if possible. Position sensors can be acquired with IO-Link functionality, which also can simplify control and parameterization.

3. Inductive sensors

Inductive proximity sensors use Faraday's law of induction to indicate an object's presence or an analog output position. The most critical aspect of selecting an inductive sensor is determining the type of metal the sensor is detecting, which determines sensing distances. Nonferrous metals can reduce the sensing range by more than 50% compared to ferrous metals. Sensor manufacturer data sheets should provide the necessary information for sample selection.

4. Pressure, vacuum

Ensure the pressure or vacuum sensor will accommodate the pressure range required as measured in pounds per square inch for imperial measurement and bar for metric. Specify the form factor most suitable for the allotted space. Consider whether machine mounted sensors should have indicator lights or a display screen as an aid for operations personnel. If changing setpoints quickly is necessary, investigate IO-Link enabled pressure and vacuum sensors.

5. Flow sensors

Like pressure and vacuum sensors, flow sensors are specified by flow range, size, and setpoint variability. They can be ordered with on sensor display options. Flow sensors can be specified for relatively low flow rates for one area of the machine and for whole machine applications.

6. Optical sensors

The most common optical sensor options are photoelectric—diffuse, reflective, and through beam. Laser sensors and fiber-optic sensing units also fall under the optical sensor category.

Photoelectric sensors are mostly presence sensors. Photoelectric sensors detect an object via reflected light or an interrupted beam of light. These sensors are among the most applied sensors in manufacturing due to low cost, versatility, and reliability.

Diffuse photoelectric sensors do not require a reflector. They are used for sensing the presence of nearby objects and are inexpensive sensors.

Through beam offers the longest sensing range and is installed at two points with an emitter unit and receiver unit. Garage door safety sensors are through beam sensors. Presence is indicated when the beam is interrupted. A fork light sensor is an interesting through-beam variant; it has an emitter and receiver in one compact unit. Fork light sensors are used for sensing the presence and absence of small parts.

Reflective photoelectric sensors have a sensor and a reflector and are used for mid-distance presence sensing. For accuracy and cost, they sit midway between diffuse and through beam.

Fiber-optic sensing units are used for presence and distance sensing. Parameters on these versatile sensors can be adjusted to detect various colors, backgrounds, and distance ranges.

Laser sensors are used for long distance presence sensing and are the most accurate in short distance measurement applications.

Vision sensors can be used for bar code reading, counting, shape verification, and more. Vision sensors are a cost-effective use of vision where camera systems would be too costly and complex. Vision sensor bar code reading can be used for tracking individual components and applying the processes identified for that component. The sensor can verify the number of features present on a part. A vision sensor can ascertain if a specified curve or other shape has been achieved. Since these sensors are dealing with light, it is vital to test the sensor in as close to the operating environment in terms of ambient light and background reflectivity as possible. In most applications, it is recommended to place the vision sensor in an enclosure to isolate it from external sources of light. It is a good idea to enlist the aid of a vision sensor manufacturer in sensor testing. Ensure the right fieldbus is specified.

The signal converter changes the analog output signal from a sensor into switching points on the signal converter, another option is to convert to IO-Link process data. **ce**

Sandro Quintero *is product marketing manager, electric automation, at Festo. Edited by Chris Vavra, production editor,* Control Engineering, *CFE Media, cvavra@cfemedia.com.*

Autotuning control: Part 1

Pros and cons: Proportional-integral-derivative (PID) controllers that can autotune sound good but face challenges.

Although the industrial automation industry has, for the most part, adopted the proportional-integral-derivative (PID) algorithm as the de facto standard for closed-loop process control, the best means of tuning a PID loop to achieve optimal performance still is an open question. The exercise is conceptually simple: Choose the gain, rate, and reset parameters that define the relative magnitude of the P, I, and D contributions to the overall control effort.

In practice, loop tuning often is more of an art than a science. The best choice of tuning parameters depends on a variety of factors including the dynamic behavior of the controlled process, the performance objectives specified by the operator, and the operator's understanding of how tuning works. A variety of manual techniques have been developed to help operators tune their loops, but even with the aid of loop-tuning software, loop tuning can be a difficult and time-consuming chore. See "Loop Tuning Fundamentals," *Control Engineering,* July 2003.

"Autotuning" or "self-tuning" PID controllers are designed to simplify matters by choosing their own tuning parameters based on some sort of automated analysis of the controlled process's behavior. These automatic procedures often involve a mathematical model of the process's input/output relationship derived from process data augmented by information provided by an experienced operator (see Figure 1).

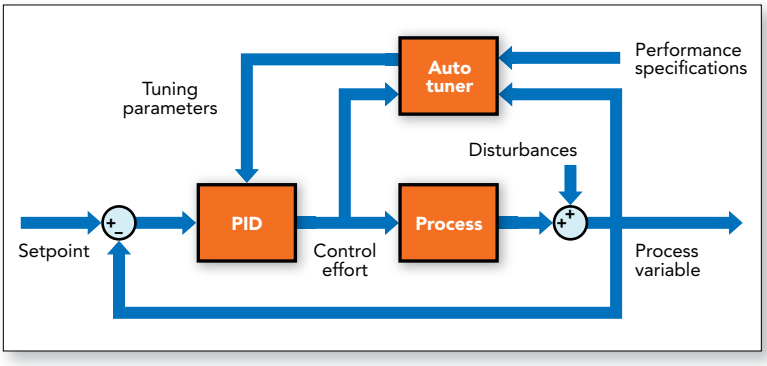


Figure 1: An autotuning proportional-integral-derivative (PID) controller measures the process's input (the control effort) and output (the process variable), then updates its own tuning parameters so as to meet the operator's closed-loop performance specifications. The best way to do so remains an open question. All images courtesy: *Control Engineering,* CFE Media

"Self-tuning" refers to such procedures continuously executed while the controller is online regulating the process. "Autotuning" refers to on demand procedures executed while the controller is offline. However, the two terms often are used interchangeably because both self-tuning and autotuning controllers automatically tune themselves. For simplicity's sake, both will be described as "autotuners" hereafter.

Step tests

The most basic autotuners simply automate the manual tuning procedures an operator might otherwise perform when commissioning a loop: force a change in the control effort, observe the results, and adjust the tuning parameters accordingly. However, autotuners vary in how they execute those steps.

For example, a basic autotuner can perform a classical "step test" or "bump test" where the control effort is changed in a step-wise manner with feedback disabled. Theoretically, the process's response to such a bump will provide sufficient information to characterize the process's dynamic behavior, which in turn will dictate the appropriate tuning parameters. In practice, however, bumping a process just for the purpose of tuning the controller can be impractical in applications where fluctuations in the process variable must be minimized at all times.

Some autotuners can avoid this problem by performing a step test while responding to a setpoint change. Because the process is going to be disturbed anyway, the controller can afford to apply a small bump to the process as it attempts to drive the process variable toward the new setpoint.

For example, refer to the back-to-back step tests shown in Figure 2. When a setpoint change is requested by the operator, the controller applies a 100% control effort (a positive step) then shuts down before the process variable reaches the new setpoint (a negative step). The controller then observes the fluctuations in the process variable to identify a mathematical model of the process's behavior.

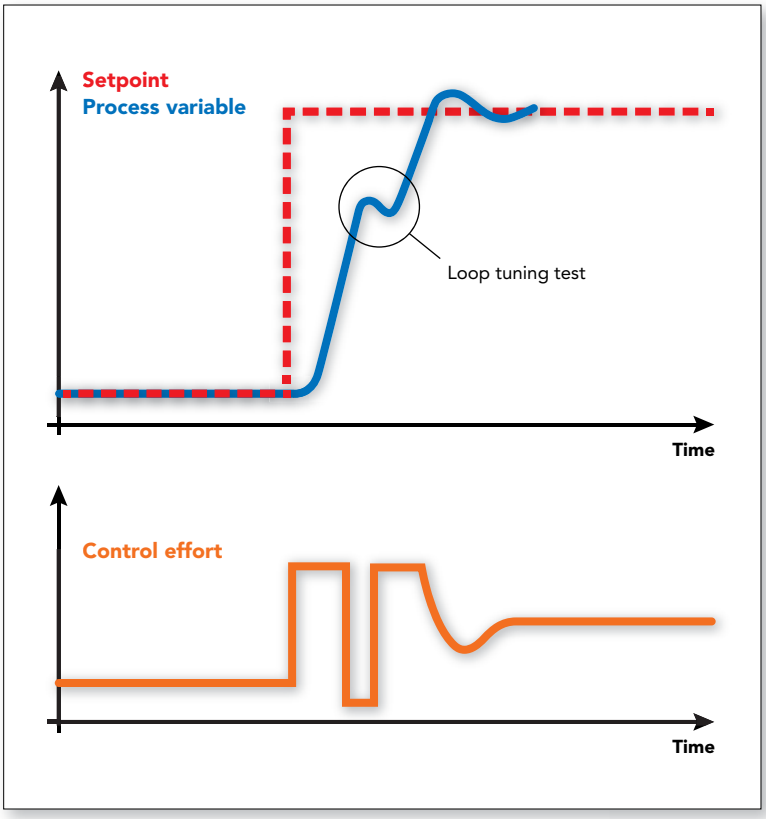


Figure 2: For some applications where the process behaves in a very predictable manner, a slight detour in a setpoint change is sufficient to identify the behavior of the process. An autotuner performing a setpoint response test interrupts the controller's initial response to a setpoint change to conduct two step tests: one positive and one negative. After one complete oscillation of the process variable, the autotuner can compute a new set of tuning parameters then reactivate the PID algorithm. By the time the process variable reaches the setpoint, the controller will have been tuned to produce the closed-loop behavior specified by the operator in terms of rise time, percent overshoot, settling time, etc.

The process time constant for the process can be derived or from the interval between the controller's shutdown and the point when the process variable begins to drop. The appropriate PID parameters can then be computed from the process deadtime, gain, and time constant using any number of tuning rules plus the operator's preference for closed-loop performance. After the tuning is complete, the controller can resume normal closed-loop control operations to bring the process variable the rest of the way to the setpoint.

Noise and disturbances

While conceptually simple, step tests can be a challenge to automate. The results will be skewed if a disturbance happens to intrude on the process variable while the test is in progress. An experienced operator performing a manual step test can generally recognize a disturbance in progress and either wait to start the test or restart it as necessary. Endowing an autotuner with similar observational skills is much trickier.

That problem is particularly acute when the process variable is subject to measurement noise. An autotuner can't always distinguish between phantom noise and real disturbances. And even when it can, the measurement noise might still corrupt the calculation of the process model by obscuring the exact shape of the reaction curve.

Some autotuners can deal with measurement noise by executing their automatic step tests more than once and then averaging the results or selecting the results that turn up most often. A sophisticated autotuner also can calculate how well its estimates of the process model fit the noisy data and either report how confident it is in its latest results or repeat the test until it reaches an operator-defined confidence level.

Still no panacea

But there are drawbacks to automated heuristic tuning as well. If the patterns of process behavior the autotuner is trained to recognize don't occur, or if the process behaves in an entirely unexpected manner, the autotuner won't know what to do. A heuristic autotuner relying on fuzzy logic or artificial intelligence to record an operator's experience can be re-trained to recognize new patterns, but an experienced operator still has to help because it can't be done automatically most of the time.

Heuristic tuning also can take a long time and several iterations to reach a final result. Heuristic autotuners tend to be conservative about how much and how often they tweak their tuning parameters lest they should end up overdoing it. **ce**

This article continues in the August 2018 issue of Control Engineering *with a look at more approaches to automatic loop tuning.*

More ANSWERS

KEYWORDS: autotune, PID

The best means of tuning a proportional-integral-derivative (PID) loop to achieve optimal performance is still an open question.

In practice, loop tuning is more of an art than a science.

The most basic autotuners automate the manual tuning procedures an operator might otherwise perform when commissioning a loop.

ONLINE

See the online version of this article for expanded text covering heuristic tuning and a third figure.

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REGISTRATION and LUNCH: 11:30 a.m. to 12:15 p.m.

KEYNOTE: 12:15 p.m. to 1:00 p.m.
Raj Batra, Siemens
In a global, competitive manufacturing environment, how can American manufacturers compete? The same way they've lifted the U.S. economy out of the Great Recession: By being smarter, leaner (and Leaner) and using technology and data to point the way to a better manufacturing strategy.

SESSION 1: 1:00 p.m. to 1:45 p.m.
Embrace your future: How robotics and AI are changing manufacturing
No longer a science fiction story, robots and artificial intelligence (AI) are real, valuable to manufacturing, and winding up in more plants than ever. How can you find the best way to utilize robots in your plant? How can AI be a training and plant management tool? Our human experts will discuss the practical ways these technologies will enhance manufacturing—and all the ways humans are still vital to your operation. Bob Doyle, vice president of the Robotic Industries Association (RIA) and the Association for Advancing Automation (A3) in Ann Arbor, Mich. and a CFE Media Partner, will lead the panel discussion.

SESSION 2: 2:00 p.m. to 2:45 p.m.
Maintenance and IIoT: Follow the numbers
The data generated by IIoT can point a maintenance professional to a problem on the plant floor—if he's looking at the right numbers at the right time. More sophisticated analytics are helping maintenance teams focus on the right data at the right time, and we'll talk with them on how this strategy can lead to more uptime and better safety. The presentation will be led by Sal Spada, research director for discrete manufacturing for ARC Advisory Group.

KEYNOTE: 3:00 p.m. to 3:45 p.m.
The Digital Twin: Changing the face of the plant floor
A digital twin establishes a direct connection between the physical product or asset and its designed, manufactured, and deployed digital representation. This connection can lead to accelerated product design, more effective maintenance operations, and a newly introduced service and business model. SAP experts will discuss the digital twin and its value to manufacturers in an engaging keynote presentation.

SESSION 3: 4:00 p.m. to 4:45 p.m.
Cybersecurity: How far do we need to go?
The problem of security for (IIoT) is one of the most discussed issues as manufacturers look to deploy this technology solution. We'll look at the real issues, perhaps debunk a few myths, and talk about the common-sense ways manufacturers can secure their data and their operational integrity. The presentation will be led by Dr. Richard Soley, Executive Director of the Industrial Internet Consortium, Chairman and CEO of the Object Management Group (OMG).

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Top 5 best practices for designing HMI for mobile devices

When designing human-machine interfaces (HMIs) for mobile devices consider critical factors such as navigation, layout, and system controls.

Well-designed human-machine interfaces (HMIs) reduce operator error, save companies millions of dollars by reducing downtime, and increase worker safety. HTML5 programming enables transferring HMI designs to mobile devices, but programming is just the enabler. The following five best practices for HMI design are specific to mobile devices due to size and interface considerations to create an enhanced experience for mobile device users.

1. Functional and user friendly

A well-designed HMI reduces user error from misunderstandings or not having all relevant information available when critical decisions are needed. The key to designing a successful HMI on a mobile interface is building one that is functional and, at the same time, delights the user. Most users are going to be running either Apple's iOS or Google's Android. Design an interface to blend into the native platform that the user is comfortable with.

Make heavy use of the native unique interface (UI) features for each platform wherever possible. This will make life easier as the platforms evolve and the users update their operating systems, which will ultimately make users feel comfortable upon opening the application.

2. Navigation and layout

HMI users need to view content and navigate to content they want to find. On a large screen, an HMI best practice is to minimize the number of physical screens to simplify navigation. An example of a well-designed HMI on a large screen might looks like this: The content is well-organized and all of the summary information is immediately visible. Each of these views can be expanded further following a hierarchical navigation structure.

However, on a mobile device, having this amount of visual information on one screen would be difficult for a user to interpret. Instead, it's important to prioritize user actions and the number of paths to reach the needed information, versus minimizing the number of screens. Start by presenting a system-level view which has the minimal level of information then provide navigation paths connecting different views for users to follow. At each view, content should fill the entire screen, while translucency and blurring can hint at more information. Avoid the use of bezels, gradients, and drop shadows as they introduce visual noise which takes the focus away from the content.

Navigation through the application should be intuitive and predictable. A good choice for a navigation pattern is a slide navigation drawer which displays many navigation targets at once, yet remains hidden until invoked by the user.

This allows a user to use the entire screen for content while still maintaining a rich navigation model between parent, children, and sibling views. This navigation model also will allow a user to switch between unrelated views while maintaining the ability present a deep hierarchical structure. It will also help users learn about alternative views or features while building a mental model of how to interact with the system through the HMI.

3. User actions

An HMI designer must consider the developer model and the user model when creating an HMI to interact with the system. On a mobile device, clearly present visual controls to the user and make interactions with controls clear. A general guideline is whenever the number of possible actions exceeds the number of controls, users may become confused or valuable features of the HMI may be obscured.

For example, critical information shouldn't be hidden behind a long press because the user may never find it. Instead, add an information button in the top corner of the screen as an overlay. This

More ANSWERS

KEYWORD: Human-machine interface (HMI)

How to design HMIs for mobile devices.

Best practices to follow to enhance a user's HMI experience on a mobile device.

CONSIDER THIS

What challenges need to be identified for your HMI design?

ONLINE

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design will subtly guide the user to discover the information without being intrusive or vague.

4. System controls

A number of control models have been developed for mobile interfaces to help minimize confusion for the user. Some common control models include:

- Use a toggle button when something can only be on or off.
- If the user can only select one option, but this option has a range of possible values such as screen brightness, use a slider.
- If the user can only select one option with a range of values, but needs fine control, use a stepper button.
- If a user needs to select one of many categorical values, the designer should use dropdowns or scroll wheels.
- As a last resort, text entry can be used since that is the slowest and most error-prone way to interact with a mobile device.

Another option is to combine tactile feedback through a vibration or sound with any of these control functions, however tactile feedback should be used only to bring visibility to interactions where visual cues are not enough.

Controls should be designed to minimize the chance of any possible errors, or its effect once it is made. Maintain enough spacing for controls so users can easily access them without making unintended touches. Also, use fullscreen pop-ups to confirm actions that can have effects that are difficult to reverse.

Mobile devices gestures are the ideal paradigm for users to interact with the HMI. Reusing common gestures will ensure your application behaves in a predictable manner. Some common gestures to consider are outlined in Table 1.

Screen-size ratios for mobile device images, controls, text

Screen resolution	Dpi	Pixel ratio	Image size (pixels)
xxxhdpi	640	4.0	400 x 400
xxhdpi	480	3.0	300 x 300
xhdpi	320	2.0	200 x 200
hdpi	240	1.5	150 x 150
mdpi	160	1.0	100 x 100

Table 2: HMIs should be designed with various screen sizes and resolutions in mind to ensure the user has a clear display.

5. Design with scale in mind

Traditionally, HMIs have fixed screens and physical controls that can be designed with those features in mind. When creating an HMI for mobile devices, a common screen resolution is no longer guaranteed. As a result, UI elements (such as a button) appear physically larger on low-density screens and smaller on high-density screens. Because of this, it's important to ensure that visuals, such as text, icons, and graphical images, are clear at every screen size users may have. To help create an HMI that can fit a variety of resolutions, follow the ratios in Table 2 so images, controls, and text will look the same when displayed across multiple screen sizes.

Following these best practices will help move an HMI to a smaller screen or mobile device and enhance a user's overall experience. The basic rules of good design are still valid provide a good conceptual model and make things visible. However, certain unique challenges require design consideration such as only being able to show limited visual information and understanding the different user interaction paradigm mobile devices require. **ce**

Joseph Zulick *is a writer and editor at MRO Electric and Supply. Edited by Emily Guenther, associate content manager,* Control Engineering, *CFE Media, eguenther@cfemedia.com.*

> "**A well-designed HMI reduces user error from misunderstandings** or not having all relevant information available when critical decisions are needed."

Mobile device gestures

Tap	**One-finger press, lift**	**Select**
Swipe	One-finger press, move, lift	Dismiss, scroll, etc.
Long press	**One-finger press, wait, lift**	**Select and element**
Pinch open	Two-finger, press, move outwards, lift	Zoom in
Pinch closed	**Two-finger press, move inwards, lift**	**Zoom out**

Table 1: Commonly used mobile gestures should be incorporated in an HMI design for mobile devices.

Mariana Dionisio, Camilo Fadul, and Cindy Scott, Emerson Automation Solutions

Five essential criteria for effective mobile HMIs

Mobile human-machine interface (HMI) strategies should consider security, ease of use, level of access and detail, and collaboration when bringing HMI interfaces from the control room to the plant floor.

Placing process control information on mobile devices for engineers, operators, managers, or maintenance technicians is becoming a necessity to enable digital transformation and elevate the performance, productivity, and safety of facility operations. Creating an effective mobile strategy is critical to the success of projects and operations to help balance the need for flexible access to operations technology (OT) information with information technology (IT) safety and security requirements.

An effective mobile human-machine interface (HMI) strategy evaluates how to bring HMI interfaces from the control room to the plant via web browsers on phones, tablets, or rugged laptops.

When developing an effective mobile HMI strategy, consider the five criteria below.

1. Native integration

Native integration means less engineering work because the process control systems and mobile technologies are designed to share and securely transfer information without requiring duplication of the system configuration.

2. Remote operator stations

Remote operator stations extend (full or limited) control outside of the control room, to the plant floor, and beyond. This interface can be a full-featured tablet or hardened laptop that gives a full view and defined control to a team member. It resides on the control network or the demilitarized zone to give a mobile team member the same power and visibility as an operator in the control room.

3. HTML5 mobile-ready HMI

An HTML5 mobile-ready HMI is an HMI display built on HTML5 technology and is thereby accessible on mobile devices and computers, without needing to duplicate the display configuration on the mobile platform. It provides display portability and ease of use to a facility's HMI plan by showing control room displays on a web browser. This enables personnel to see the same data and graphics securely as operators in a facility remotely, which can help ease collaboration between control room personnel and by remote personnel.

4. Mobile applications

With tailorable, view-only data access, mobile applications are broadly used as secure technologies designed to encourage personnel to remain informed and engaged regardless of location.

Whether a remote operator workstation, an HTML5 mobile-ready HMI, or a native mobile application, these solutions can be securely and easily integrated into daily processes and work practices, to yield the desired productivity, performance, and safety improvements.

5. Consider total cost of ownership

While many technologies provide potential solutions, the ideal solution offers a strong lifecycle value that balances easy, low-cost upfront implementation with security and minimal long-term engineering. The success of this strategy depends on choosing a solution that matches OT and IT strategies and that personnel can incorporate to daily operations. **ce**

Mariana Dionisio, Camilo Fadul, and Cindy Scott are DeltaV strategy leaders for mobility and HMI design for Emerson Automation Solutions. Edited by Emily Guenther, associate content manager, Control Engineering, *CFE Media, eguenther@cfemedia.com.*

More ANSWERS

KEYWORD: Human-machine interface (HMI)

How to implement an effective mobile HMI strategy.

The benefits of having a mobile HMI strategy.

CONSIDER THIS

How can your facility strategize implementing a mobile HMI solution?

ONLINE

Read more online about the essential criteria for effective mobile HMIs.

Devices like the Emerson Automation Solutions DeltaV remote operation station, which is shown on a Panasonic Toughpad, can provide a full operation station experience in a rugged, easy-to-use mobile form factor. Courtesy: Emerson Automation Solutions

2019 System Integrator of the Year

Entries are due August 17, 2018

Control Engineering and
Plant Engineering's annual
System Integrator of the Year Awards

CONTROL ENGINEERING
2019 System Integrator of the Year
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The chosen System Integrator of the Year winners will receive worldwide recognition from *Control Engineering* and *Plant Engineering*. The winners also will be featured as the cover story of the Global System Integrator Report, distributed in December 2018.

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Project: Automation, controls

Case studies in oil and gas, pharmaceutical, and water-wastewater applications offer advice in control system integration, automation upgrades, and project management.

Representatives from *Control Engineering* and *Plant Engineering* 2018 System Integrator of the Year winners were asked to discuss challenges and successes relating to a recent automation, controls, or instrumentation project.

Responding were:

- **Nigel James,** chief strategic officer, director of business development, Burrow Global.
- **Ron Pflum**, senior control systems engineer with Automation Plus.
- **José Palazuelos**, general manager of ECN Automation Inc.

1. For a recent successful automation, controls, or instrumentation application for your firm, what was the industry and facility type?

James: A Gulf Coast refinery.

Pflum: The industry was pharmaceutical and life science, and the facility type was final product intermediates manufacturing.

Palazuelos: A food and beverage reverse osmosis (RO) water treatment facility.

2. What was the scope of the project and goals?

James: This project included front-end engineering design (FEED) and detailed engineering services. The scope addressed the replacement of a legacy distributed control system with new process control system equipment. The project included wiring reports, engineering calculations, equipment specifications and procurement. Process and instrumentation diagrams (P&IDs) were updated to reflect new symbology. Remote instrument enclosures (RIEs) were designed to house process control equipment and included redundant uninterruptible power supply (UPS) and HVAC systems. The scope of work also included equipment and construction bid analysis, construction support and start-up services. Detailed equipment factory acceptance test (FAT) and site acceptance test (SAT) procedures were developed and executed. Hot-cutover procedures were developed and executed for all loops. Architecture was developed for three critical programmable logic controller (PLC) systems.

Pflum: The scope included upgrades to the legacy PLC system, and updating the network infrastructure that controlled the process equipment (purification) at a major pharmaceutical manufacturer.

The goals included:

1. Streamline the manufacturing process and reduce batch cycle time
2. Mitigate risk due to lack of availability of replacement parts
3. Enhance the operator interface
4. Enhance security and data integrity.

Palazuelos: We replaced obsolete PLCs, inputs and outputs (I/O), and communication networks for existing variable frequency drives (VFDs) to control a water transfer system and the reverse osmosis water treatment system.

3. What types of automation, controls, or instrumentation were involved?

James: A legacy distributed control system was replaced with modern process control system from the same vendor.

Pflum: Controls and information technology (IT): Complete process automation system design used the hardware from a major automation vendor, replacing legacy PLCs and operator interface terminals.

The upgraded platform is a distributed industrial controller-based system with field I/O, and virtualized server stack using a supervisory control and data acquisition (SCADA) system

More ANSWERS

KEYWORDS: System integration, case studies

System Integrator of the Year case studies.

Planning is important for project management.

With upgrades greater efficiency is possible.

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For a Gulf Coast refinery controls upgrade, Burrow Global designed remote instrument enclosures (RIEs) to house process control equipment and included redundant uninterruptible power supply (UPS) and HVAC systems. Courtesy: Burrow Global

Nigel James is chief strategic officer, director of business development, Burrow Global.

Ron Pflum is senior control systems engineer with Automation Plus.

José Palazuelos is general manager of ECN Automation Inc.

software platform, forming the core of the automation system.

In addition to the control system design, a full network design was provided using a redundant industrial server with multiple virtual machines. I/O subsystems and field devices also were specified and upgraded as a part of this project.

Process automation software was used from the same automation vendor. Our team provided integrated monitoring and control sequences for the material dosing, mixing, reaction, and transfers associated with the client's unique batch and continuous manufacturing process.

Palazuelos: The project involved legacy PLCs, a legacy PLC network, and an operator interface terminal from a non-PLC HMI vendor. Everything was upgraded to a modern programmable controller family, with EtherNet/IP [industrial Ethernet protocol from ODVA] connectivity to VFDs, and the plant's supervisory network.

4. What were particular challenges outlined in the project?

James: The schedule was a challenge; ensuring we did not miss anything in the migration (there were many moving parts); as well as OSHA compliance; and cutover risks as the refinery switched from old to new controls. Deliverables included the design for a 1,530-sq-ft blast-resistant RIE, eight controllers for regulatory control and sequence operations, marshaling panels, more than 2 miles of diverse fiber-optic cables, and two satellite houses to accommodate specific field signals. The hot-cutover team transferred 2,664 loops to the new distributed control system (DCS). Approximately 320 control valves were transferred during hot cutover.

Pflum: The largest challenge on the project was to execute within the client's accelerated schedule, minimizing commissioning downtime, and maintaining code integrity in a fully validated environment.

Palazuelos: Project challenges included:

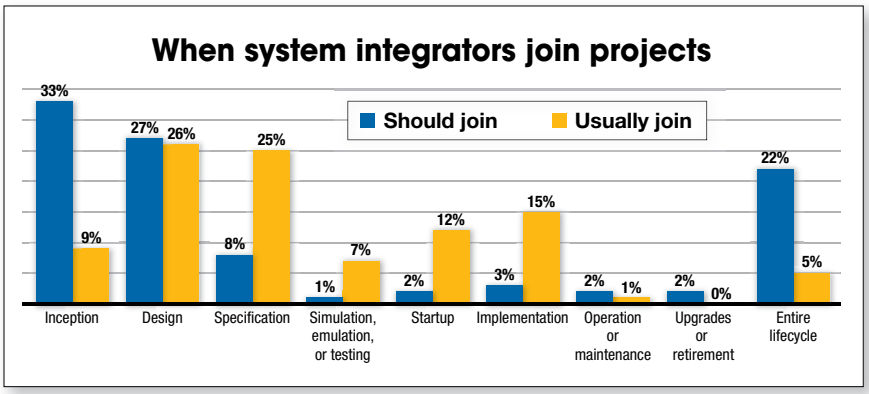
- The control panel for the water transfer system and RO was feeding water to the plant, which limited downtime to the scheduled maintenance shutdown to avoid production losses.
- Limited space from existing enclosures without proper accessories to protect I/O and devices.
- naccurate documentation.

5. How were those issues resolved?

James: For detailed front-end loading (FEL), a stage-gate process was used and a detailed scope was developed for all to review. A personnel-loaded schedule was developed. Safety integrity level (SIL) calculations were performed to ensure OSHA compliance. Plans were developed for cutover.

Pflum: Automation Plus executed a collaborative FAT in our simulation center earlier than normal (to our standard project methodology). This allowed for a faster development and deployment time cycle. Our project manager was immersed within the technical team to drive alignment within design and programing creation and reviews to further integrate the team to reduce schedule. As deployment neared we were working with the validation team (in house) to streamline documentation and keep documentation up to date as modifications form field install were noted. These items, coupled with an increase in deployed resources (24/7 support coverage), drove a successful commission and validation of the installed system within the downtime allocated.

Palazuelos: A combination of premanufactured wiring systems, terminals, and a new backplane was used to reduce downtime to a minimum.



More than half of respondents think system integrators should join a project much sooner than they actually do, according to this *Control Engineering* research highlighted in December 2015. Courtesy: *Control Engineering*

To solve the issue of documentation, a deep understanding of the process, the instrumentation, and equipment running was combined with what was available from the original prints. Cross references were run with PLC logic backups to re-document the PLC program during the conversion process.

On the matter of space, we took the opportunity to eliminate some unnecessary I/Os by using communication networks to control pumps and VFDs using EtherNet/IP. Multilevel terminals and small form relays also were used to make sure all necessary components were included.

6. Please share some positive metrics associated with the project.

James: Hours per point (hr/pt) and hours per drawing (hr/dwg) for benchmarking engineering services were used, as well as loops/day for the cutover process. A proactive quality assurance and quality control (QA/QC) process was used.

Pflum: The critical metrics associated with this project for our client included:

1. Reduced maintenance and risk (the client now has spare parts in the store room and a local distributor with a full inventory)
2. Improved efficiency in the manufacturing process (the client has had batch cycle time reduction in some cases ~50%)
3. Improved product quality through more consistent process control.

Palazuelos: Downtime within existing plant maintenance shutdown, which meant we had 5 days to migrate the processors and I/Os. We were ready within 3 days to start functional tests of the plant.

7. What were lessons learned or advice you'd like to share?

James: When using the FEL process, see the Dan Roessler Book from Momentum Press as a best practice: "Control System Migrations: A Practical Project Management Handbook."

Pflum: Lessons learned included to be flexible with client requirements and adapt your standard practices and methodologies to the situation, when possible.

In short, be nimble. Make progress where you can, on an accelerated project certain execution tasks may require a precursor, use the project leader/manager to identify those items early, and then position the team to allow for execution in parallel paths without hindrance.

Lastly, with any regulated client, but certainly life sciences, maintain a full set of up-to-date documentation of the control system and programming specifications. These documents are critical to the system integrator, end user, and the validation partner.

Palazuelos: Always check compatibility from existing infrastructure when providing new hardware and communication protocols as you can face limitations from the existing plant architecture.

In our case, we had to upgrade some drivers from the SCADA system to be able to communicate with the latest firmware versions and hardware that were used. Unfortunately, not all systems are ready to perform these operations.

During migrations or upgrades of legacy equipment, a customer can use that opportunity to increase the functionality or performance of the machine, providing new operation and maintenance information tools.

These added features will help troubleshoot the machine in the event of an unplanned shutdown and provide opportunities to improve the efficiency of the process with the new information available for analytics. **ce**

*Edited by **Mark T. Hoske,** content manager,* Control Engineering, *CFE Media, mhoske@cfemedia.com.*

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Lindsey Kielmeyer, MartinCSI

Case study: IIoT effectiveness on the plant floor

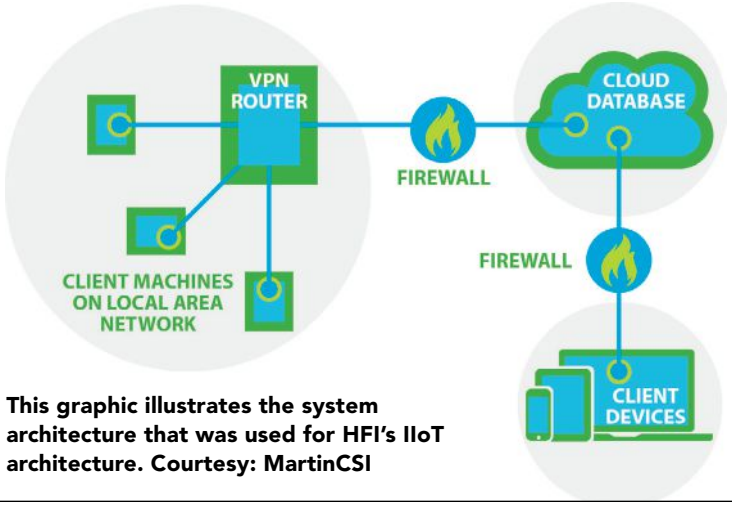
Collect data to augment equipment effectiveness and for machine efficiency.

Automotive supplier HFI approached system integrator MartinCSI to implement Industrial Internet of Things (IIoT) technologies to capture what was happening on the plant floor and relay that information to management for analysis. Weeks later, HFI had access to machine data, overall equipment effectiveness (OEE) metrics, and remote access to reporting.

The IIoT challenge

Like many manufacturers, HFI was ready to explore the advantages of implementing IIoT capabilities and data analysis.

IIoT implementations tout the ability to identify trends, analyze Big Data, provide actionable insights, and increase productivity. HFI had another



This graphic illustrates the system architecture that was used for HFI's IIoT architecture. Courtesy: MartinCSI

systems integrator implement an application that captured data from one machine. A significant amount of machine data had been collected with information on every sensor, input, and output.

A lot of data was available, and no one knew exactly what was important, who to get it to, or how to benefit from it. It just sat there.

IIoT data relevancy

MartinCSI designed a system to collect machine data, store it on a cloud server, and provide HFI with direct access to the database. The implementation did not require purchasing expensive hardware, smart sensors, or equipment with embedded intelligence. HFI's existing supervisory control and data acquisition (SCADA) and network architecture remained unchanged.

The system integrator and client worked with HFI to create OEE metrics and reports that were used to determine machine efficiency. MartinCSI facilitated the collaboration of multiple departments in HFI to establish the most relevant machine data points to collect and feed into the data visualization application used for custom reporting.

The system integrator also delivered useful information to HFI personnel enabling them to make meaningful decisions to promote increased productivity, quality, and profitability.

IIoT results

After analyzing the collected OEE metrics and reports, HFI was surprised to find the machine was operating at 50% capacity. Tools also were provided to make well-informed, intelligent decisions. HFI was able to investigate the cause and work with engineering and production to develop a path toward increased machine uptime.

Real-time reporting shows what impact the changes are having on production. Once they have established best practices for efficient machine operation they can roll out a systematized process across all locations. The out-of-the-box features and easy installation allowed deployment as needed with "standard metrics and KPIs [key performance indicators] with an integrated view of multiple facilities," not provided in other technologies Karen Hartley, the HFI director of IT, had seen. **ce**

__Lindsey Kielmeyer__ is marketing coordinator, MartinCSI. Edited by Emily Guenther, associate content manager, Control Engineering, *CFE Media, eguenther@cfemedia.com.*

More ANSWERS

KEYWORD: Industrial Internet of Things

How MartinCSI devised an effective IIoT strategy for HFI

Real-time reporting shows the impact changes are having on production.

CONSIDER THIS

What kind of data needs to be collected and analyzed to improve machine efficiency?

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Mark T. Hoske, *Control Engineering*

Observation wheel: safety, motion

CASE STUDY: Automation's attention to safety, reliability, and ease of implementation at an Orlando observation wheel.

Even when motion control is used for fun, considerations such as safety, reliability, and ease of implementation remain, as the automation equipment implemented at an Orlando observation wheel demonstrates.

In a media and analysts tour during the 2018 ARC Forum, Bill Kivler, vice president, facilities and engineering, I-Drive 360, provided application information. Kivler's prior experience included 23 years of operations experience at Disney World.

The observation wheel, originally the Coca-Cola Orlando Eye, was renamed ICON Orlando in May. The 400-ft tall ride operates 365 days per year, 10 a.m. to midnight, with 1500 passenger per hour capacity in 30 3-ton air-conditioned capsules. It opened in 2015. Each car holds 15 passengers for a 22-minute ride. Intamin Amusement Rides, based in Liechtenstein, built the Orlando Eye and the London Eye.

Siemens automation helps this 400-ft-tall observation wheel in Orlando. Courtesy: Mark T. Hoske, *Control Engineering*

Project scope, goals, automation

Passenger safety was foremost, correcting load shifts in each car to maintain stability of each. Reliability and availability were important; downtime is lost revenue, so maintenance and self-diagnostic capability were critical. AWC Inc., a Siemens partner with the automation provider, provided local service and support.

Motion control, safety, and related operator controls and power included integrated automation and motion control with drives and wired and wireless communications, Power-over-Ethernet (PoE), advanced programmable logic controllers (PLCs), TUV-certified fail-safe software controller, redundant PCs, operating system, radio voice communications, integrated safety and cybersecurity features, and remote input/output (I/O).

For the controls, including capsule motion control, Intamin deployed PLC software and PLCs on dual, redundant PCs, each with automatic failover. The software controller has functional independence from the Microsoft Windows 10 operating system so operation continues during a Windows restart or failure. PCs reside in the control booth; three trained technicians provide human oversight of the wheel's operation. Operators have full wheel views, inside and out, via video in each capsule and from overlapping fields of view from cameras mounted on the wheel's superstructure. Operators have radio voice communications with the person loading passengers into each module.

Remote I/O modules (in a small panel in each passenger capsule) communicate with the PLC controls over an industrial Ethernet network via industrial wireless technology. Local motion control for 14 motor drives is arranged in a 7x7 counter-opposed configuration. This design minimizes capsule motion. The wheel operates using a 7 kW electric motor, which has two redundant backup generators for immediate switchover, should local utility power fail.

Remote I/O modules in each passenger capsule communicate with the master PLC software controller via an industrial wireless LAN (WLAN) comprised of IEEE 802.11n radio access points and client modules transmitting over an industrial Ethernet protocol. (IEEE 802.11n is a higher-throughput subsection of the international standard for wireless local area networks (WLANS)).

E-stop functionality is a click away, backstopped by automated pre-sets if certain conditions occur. The control booth personnel monitor the PLC software for a wide range of operating parameters, including wheel and capsule speeds, motion control

More ANSWERS

KEYWORDS: Entertainment motion control, safety

Motion controls at an Orlando observation wheel

Weeks of programming time were saved with drag and drop software with libraries.

Motion control and safety are via wireless communications.

CONSIDER THIS

If industrial wireless is used for critical motion control, what could it do in your applications?

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Near the top of this enclosure, Sinamics S120 Coordinated drives system (line module and motor modules) provides control for an Orlando observation wheel. Courtesy: Mark T. Hoske, *Control Engineering*

drive status, capsule weight, motion, and A/C temperature, and others.

The software controller used is the first TÜV-certified fail-safe software controller. It includes integrated safety features, certified in accordance with International Electrotechnical Commission (IEC) 61508 Functional Safety of Electrical/Electronic/Programmable Safety-Related Systems, for remote I/O communications for local control of the drives on each capsule.

The wireless components combine reliability and security in a solid-state, rugged aluminum package well-suited for the application. Using multiple-input, multiple-output technology to multiply the capacity of radio channels, they can achieve bandwidth throughputs of up to 450 Mbit/s, more than enough for the wheel's requirements.

Access points and client modules have PoE to minimize cabling. Protection against unauthorized access is provided by advanced firmware mechanisms for user authentication and data encryption. The ride safeguards its wireless and wireline networks with a layered, defense-in-depth cybersecurity program.

Project metrics, numbers, lessons

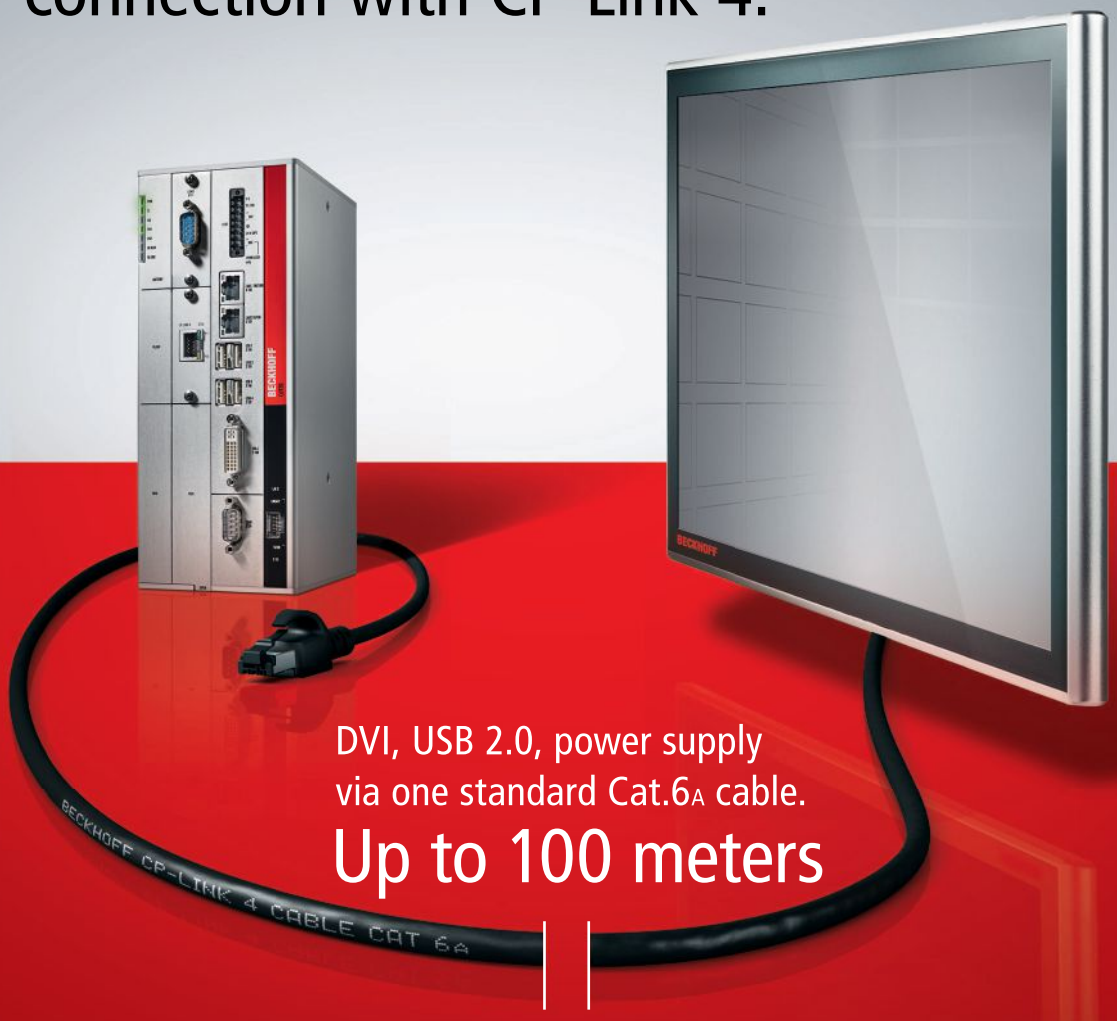
Software engineering for the project was performed in the automation vendor's development software, providing a common framework for component programming with a drag-and-drop interface and libraries of software code, which saved Intamin weeks of controls programming time in the ride's development. Intamin engineers and service technicians can remotely dial into the software controller and work with Kivler's team to provide troubleshooting guidance and address any operational issues.

"With multiple vendors tied into your infrastructure, you have an integration nightmare, with much more potential for sub-optimal performance of your overall systems," said Kivler. "Of course, when something goes wrong, troubleshooting the root cause becomes one big game of finger-pointing."

With the gear used, Kivler added, "Everything is so well integrated and self-diagnostics in the components are so deep and wide, problems get resolved in a small fraction of the time, compared to what a multivendor environment would require, with all the guessing and trial-and-error going on." **ce**

*Edited with notes and information from a Siemens February media and analyst tour by **Mark T. Hoske**, content manager,* Control Engineering, *CFE Media, mhoske@cfemedia.com.*

One cable does it all: Flexible, long-distance panel connection with CP-Link 4.



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Allied Moulded Products, Inc. is a leading manufacturer of nonmetallic electrical enclosures in today's commercial and industrial markets. Enclosures can be found all over the world in many different control applications such as industrial & manufacturing plants, waste water treatment, wind turbines, security, SCADA, solar, marinas, data & telecommunications, mining, factory automation and more. The extensive line of NEMA Type 4X/IP66 fiberglass reinforced polyester (FRP) enclosures, made with proprietary ULTRAGUARD® resin formulation, outperforms competitors in the areas of yellowing, gloss retention, discoloration and change in texture.

Allied Moulded offers a complete range of sizes, from small junction and push button enclosures to JIC sizes to freestanding cabinets; you're sure to find the size that is perfect for your unique application. To complement the full line of enclosures, Allied Moulded offers a complete solution to your industrial enclosure needs with accessories and customizations. In addition to fiberglass, Allied Moulded also offers a line of polycarbonate, injection-molded enclosures. Choose what's right for your specific needs!

Premium Accessories for Enclosures

Allied Moulded has a complete line of accessories to enhance any enclosure application. Our line of HMI cover kits now has a prop arm to make access to controls quick and convenient. Other accessories include a NEMA 4X vent kit, ULTRAPLUG® hole plug assemblies, pole mounting kits and more.

A Trusted Partner

Allied Moulded continues to be a leading manufacturer of nonmetallic electrical enclosures and a "one-stop resource" where fiberglass and polycarbonate products can co-exist depending on the specific application characteristics and chemical compatibility requirements.

For more information about Allied Moulded, visit www.alliedmoulded.com.

ALLIED MOULDED PRODUCTS, Inc.

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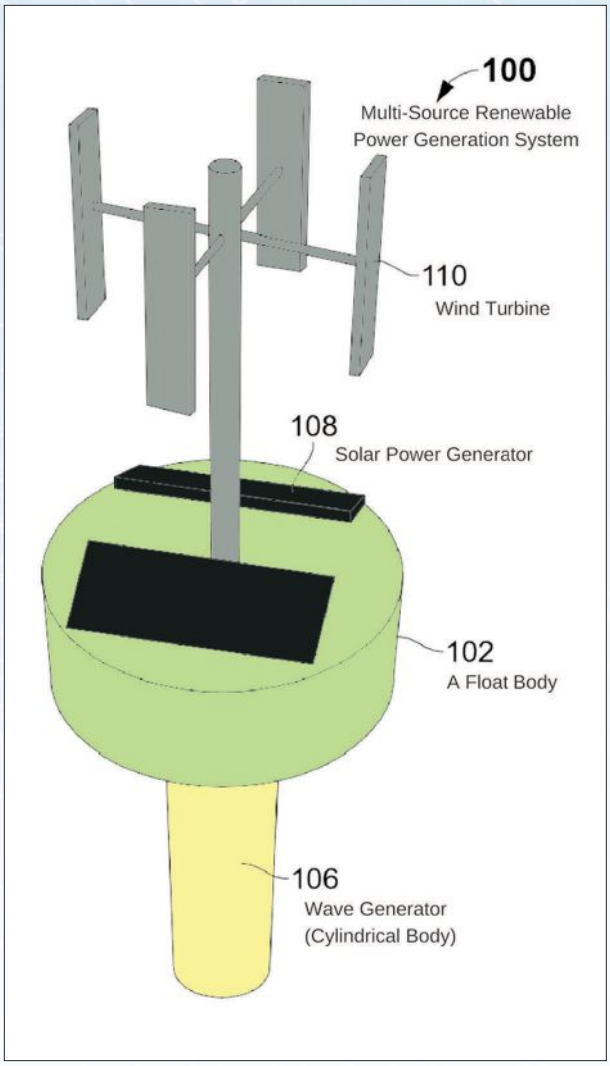
Tel: 800-722-2679 | Fax: 800-237-7269 | sales@alliedmoulded.com | **www.alliedmoulded.com**

Multi-Source Renewable Power Generation System

(Patent Pending)

By Laura Gong

Energy production is a worldwide concern. Fossil-fuel power plants emit pollutants and discharge harmful effluents. Renewable energy technologies such as photovoltaic plants or solar collectors, water power plants and wind energy plants are energy generation plants that have a much lower environmental impact than conventional energy technologies. However, each of the above-mentioned power plants has its own drawbacks.



Due to the unpredictable weather conditions, the ability to control and predict energy generation from renewable energy sources represents a considerable challenge. Therefore, my design utilizes a combination of renewable energy sources from the sun, waves, and winds to provide a reasonably steady and continuous source of electricity.

The renewable power generating system comprises a frame including a float body and a cylindrical body which is integral to the float body. Solar and wind energy is generated in the float body while wave energy is generated in the cylindrical body. The cylindrical compartment comprises a cylindrical magnet and a coil comprising magnet wire.

The solar panel above the float portion receives the solar power energy and produces electrical potential. To utilize a maximum surface area on the float body, flexible solar panels are placed alongside standardized solar panels.

The cylindrical body harnesses energy from wave motion on the surface of the liquid. The wave energy generator comprises a point absorber to capture the vertical and horizontal motions of the wave. Through these motions, the cylindrical magnet produces electromotive force through an electromagnetic induced flux.

This wind turbine receives wind from any direction to harness wind energy. The vertical axis wind turbine, which comprises multiple wind turbine blades, is placed on the float body. The turbine blades are in mechanical communication with a rotor by translating force, and it is responsive to wind power.

Advantageously, my design enables utilization of at least three sources of ambient energy. This combination of renewable energy design provides a steady and continuous source of electricity to consumers.

For technical information, please visit:
www.thepowergensystem.com/
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Athena Tech Inc. owns the right for the future development

eAthena

INNOVATIONS FROM THE INDUSTRY

AutomationDirect

Company headquarters located just north of Atlanta, Georgia

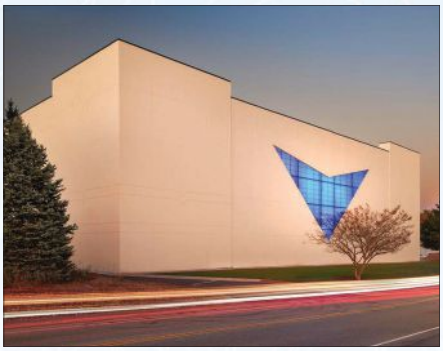
A well-recognized name in the industrial automation market, AutomationDirect is a distributor of thousands of products including Programmable Logic Controllers (PLCs), AC/DC drives and motors, operator interface panel/HMIs, power supplies, sensors, pushbuttons, NEMA enclosures, pneumatic supplies, wire, and much more. In business since 1994, the company headquarters is located just north of Atlanta, Georgia.

For over 20 years we've been saving our customers time and money on industrial automation products. We have a huge inventory that is constantly growing in order to provide you with the quality components needed to keep your projects on schedule. We've heavily invested in new infrastructure that will allow us to continue offering the service and support you deserve.

We make ordering easy and our service is exceptional. Shop online with our exhaustive product listings or browse our online catalog; fax or phone us – you'll get friendly, efficient service from the most helpful sales team in the business. Independent surveys completed by readers of industrial trade magazines for their Readers' Choice Awards have placed us at the top of the list for service 15+ years in a row.

We ship super-fast (and FREE on orders over $49). The majority of our products are stocked for same-day shipping, when you place your order by 6p.m. E.T. (with approved company credit or credit card). Plus, you get free two day (transit) shipping on orders over $49 within the U.S., Canada and Puerto Rico; shipped via ground service or LTL (certain heavy items are excluded). We guarantee it.

We want you to be pleased with every order. That's why we offer a 30-day money-back guarantee on almost every stock product we sell, including our software (see Terms and Conditions for certain exclusions).



Orders ship quickly from our state-of-the-art warehouse

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Are you ready for batch size one?

The new generation of 'digital native' consumers expects no less.

The concept is for the consumer to order on line, to produce and package customized products inline, and ship direct from your smart factory tothe consumer.

B&R Industrial Automation is singularly capable of providing the adaptive machine technologies to enable your mass customization strategy.

Dedicated machine designs are giving way to base machine modules that are configured to production requirements, reconfigured as needed and support 'batch of one' operations.

The result is a new category of machinery, the adaptive machine. Download B&R's white page on this topic at **http://bit.ly/2EOdPLu.**

Batch size one gives manufacturers a direct-to-consumer e-commerce strategy

At its core is track technology, with each product transported and processed on an independently controlled shuttle for unprecedented flexibility.

With the adaptive machine, 'changeover' is obsolete, as changes can take place with every cycle. Dedicated machine designs are giving way to the adaptive machine, enabling batch size one to compete for consumers who are 'digital natives.'

Along the way, tasks are performed with speed and precision by synchronized robot arms and devices. This performance is made possible by an advanced automation platform, characterized by a single controller, running a single integrated software application on a single powerful processor. It's definitely not your average PLC — but it has the same familiar look and feel to technicians and operators.

Marc Ostertag — President, B&R Industrial Automation North America

The world is changing, and it is an exciting time to be in automation. Won't you join with us?

Adaptive machinery is now entering the market and will have a profound impact on e-commerce, consumer goods processing and packaging, assembly, medical device and kit production, and much more.

B&R Industrial Automation is leading the trend, combining track technology with scores of complementary automation software functionalities. The world is changing, and it is an exciting time to be in automation. Won't you join with us?

Learn more by requesting our white paper, The Adaptive Machine: Design Strategies & Attributes, by emailing us at marketing.us@br-automation.com.

Stay informed with the latest automation trends and news by subscribing to our digital magazine, Automation Strategies at **http://bit.ly/2EOmaif.**

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INNOVATIONS FROM THE INDUSTRY

ABB

ABB's US motors and generators business, formerly known as Baldor Electric Company, produces and supports their products from more than 15 locations in Arkansas, Oklahoma, Missouri, Mississippi, Tennessee, Georgia, North Carolina and South Carolina. Based in Fort Smith, Arkansas, they are the leading marketer, designer, manufacturer and service provider of industrial electric motors, mechanical power transmission products, and generators.

ABB is the largest motor and mechanical power transmission company in North America. They sell, service and support the entire range of ABB IEC motors, Baldor-Reliance® NEMA motors, and above NEMA medium and high voltage motors up to 100,000 horsepower. They are also the leading provider of mechanical power transmission products with Dodge® mounted bearings, enclosed gear products, and power transmission components, including sheaves, couplings, and conveyor pulleys.

ABB offers dedicated market expertise and product solutions for the mining, food & beverage, oil & gas, paper & forest, aggregate & cement, unit & air handling, water and power generation industries.

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BALDOR - RELIANCE DODGE®

www.baldor.com | 479-646-4711

Industry 4.0: Focused Expertise for Industrial Automation

Balluff sensors and identification systems collect, and Balluff networking solutions reliably transport the data to the supervisory systems for interpretation. Industry 4.0 relies on the availability of relevant data in real time and the ability to derive the value-added stream of information from the available data at any time.

Balluff's United States headquarters in Florence, KY

Realization of the Intelligent Production System

Industry 4.0 implies intelligent production systems. Balluff can provide you with the necessary technologies and is focused on expertise for the realization of the intelligent production systems. As a reliable partner for industrial automation, they can work alongside you to increase the efficiency and profitability of your processes, making you more competitive.

Customer Support Across the Country

Balluff's North American headquarters has been located in Florence, Kentucky since 1983. Balluff Inc.'s Florence campus includes a new state-of-the-art Customer Support Center and Supply Chain Management building.

Tony Canonaco
Balluff Inc. President/CEO

The Florence location specializes in the production and market-leading delivery of linear position sensors. In addition, it is the North American distribution and warehouse center for Balluff. Over 180 employees and a premier distribution network allows us to support our customers in every area of the country.

When it comes to quality, Balluff, holds itself to a higher standard. Products are tested in an accredited lab with a quality management system that is certified according to the latest ISO 9001:2015 standard.

Industry 4.0 relies on the availability of real-time, relevant data

Like to know even more? Contact Balluff today to connect with one of their knowledgeable local representatives: Balluff@balluff.com or 1-800-543-8390.

BALLUFF

Balluff@balluff.com | 1-800-543-8390 | **www.balluff.us**

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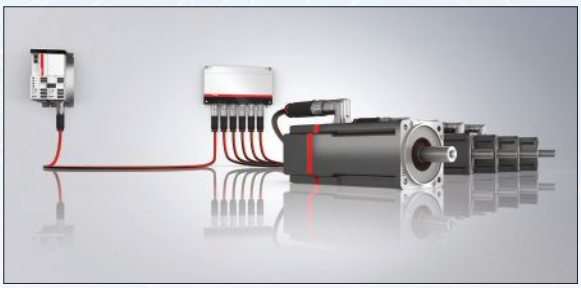
New Beckhoff AMP8000 Distributed Servo Drive System Promotes Space Savings

Integrated drive technology reduces machine footprint and control cabinet space requirements

Beckhoff Automation has introduced the new AMP8000 distributed servo drive system, which breaks new ground for modular machine concepts. The space-saving AMP8000 integrates a servo drive directly into a servomotor and features an ultra-compact design. By relocating the power electronics directly into the machine, a control cabinet only needs to house a single coupling module in order to supply power to multiple servo drives with a single cable via the distribution module. This results in significant savings in terms of cost, space, materials and installation effort.

With the AMP8000, space requirements for drive technology inside of electrical cabinets are reduced to a single coupling module. Via EtherCAT P technology, which provides EtherCAT signals and power over one cable, such a coupling module can control up to five distributed AMP8000 Servo Drives via an IP 67-protected AMP8805 distribution module. Since the entire AMP8000 system is cascadable, even complex motion systems can be implemented with a remarkably simple topology.

In addition, Beckhoff offers preassembled cables that simplify logistics considerably and minimize wiring errors. With fewer and smaller cable routes to the motors, installation efforts are significantly reduced.



Optimized design for efficient drive integration

The drive integration concept of the AMP8000 features an exceptionally compact design. Since the power module is conveniently located at the back end of the motor shaft, the attachment dimensions of the new distributed servo drives are identical to those of the proven standard AM8000 series servomotors. The only dimensional change is to the overall servomotor length, which is extended by approximately seven cm. For the machine builder, this means that only a little additional space is needed at the motor end, so adjusting the overall motion control concept is easy, and existing machine designs do not need to be otherwise altered.

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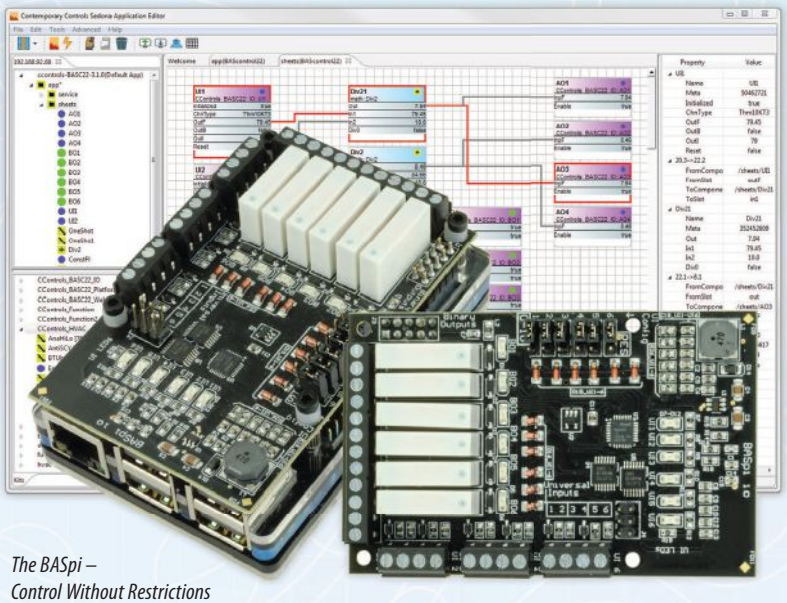
BECKHOFF

For more information on the AMP8000 distributed Servo Drive system, go to **www.beckhoff.com/amp8000**

Turning a Micro PC into a Control Device

BASpi leverages both open hardware and open software



The BASpi – Control Without Restrictions

Contemporary Controls recently released a BASpi I/O board for Raspberry Pi, which turns the already powerful Raspberry Pi3 into an extremely capable control device with web-based configuration, universal IO, and industry standard data communication and control protocol – BACnet.

Two versions of the BASpi are available. One is the BASpi I/O board for those people who already have a Raspberry Pi and are experienced with programming it. The other version is an entire system, which includes the Raspberry Pi 3 board, the BASpi I/O board, an industrial grade µSD card with pre-written image, international power supply, and an enclosure case.

The I/O board, plus the firmware files provided by Contemporary Controls, turn a Raspberry Pi into a BACnet-networked, Sedona-programmable controller with 6 universal inputs, 6 relay outputs, and 24 BACnet virtual points. Software support for the BASpi includes a graphical programming tool, project backup and restore utility, and an emulator packaged in the free BAScontrol Toolset.

The BASpi gives home enthusiasts, students, and DIYers a truly open controller they can easily set up and use. It includes a Sedona Virtual Machine (SVM) that can be freely programmed using Sedona's drag-and-drop methodology of assembling components onto a wire sheet to create applications. Contemporary Controls provides a free Sedona Application Editor to assist with programming.

Besides being an open Sedona controller, the BASpi is BACnet/IP compliant. Configuration of BACnet points is via web pages. Time-of-day is handled with a NTP server.

With both Wi-Fi and Ethernet ports on the Raspberry Pi, it is possible to be attached to a BACnet head-end on the Ethernet port while programming the controller over Wi-Fi.

To learn more about the BASpi visit **www.ccontrols.com/baspi.**

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CONTEMPORARY CONTROLS®

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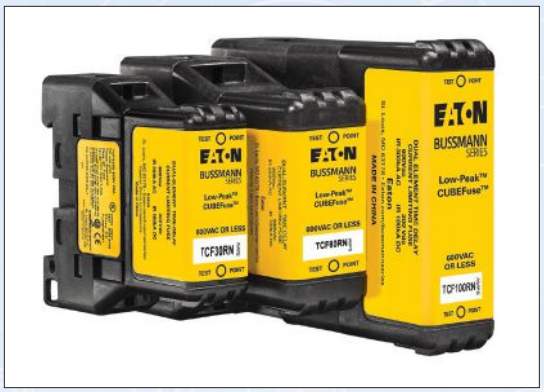
Bussmann series CUBEFuse: In a Class of Its Own



Bussmann series CUBEFuse and holder, 1-100 A

Innovation comes from many sources, but the best is when a customer says, "I wish…" Robert Douglass, lead engineer for Bussmann series products, met with a switchgear manufacturer engineer, who placed a Bussmann series UL® Class J and Class CC fuse in front of him, and challenged Douglass to come up with a solution that put Class J performance into a Class CC footprint.

Robert Douglass

Douglass couldn't let go of that customer insight. In 2000, the Bussmann™ series CUBEFuse™ was unveiled boasting Class J electrical performance in the smallest installed footprint of any class fuse, including Class CC, J, T and RK. The CUBEFuse also features high interrupting rating up to 300 kA, finger-safe, plug-in construction, and is available from 1 to 100 amps.

Bussmann series Quik-Spec Coordination Panelboard

Originally designed with its own DIN-Rail mounted holders, the CUBEFuse found its way into new Bussmann series products, including the UL® 98 Listed Compact Circuit Protector (CCP) and the Quik-Spec™ Coordination Panelboard.

Today, the CUBEFuse, the only product included in the UL Class CF, continues to solve industry challenges:

- A VFD manufacturer experienced damage from inadequate short-circuit protection in its water booster pump. The CUBEFuse and CCP solution allows for isolation of branches via its disconnect capability, plus a finger-safe solution all at a much higher SCCR.
- System reliability, arc flash hazard reduction, and simplified selective coordination were "must-haves" for a college campus project. The Bussmann series QSCP with 200 kA rated CUBEFuse, compact footprint, and finger-safe attributes, were desired features.
- One large utility was looking for selective coordination and a standardized circuit protection solution for its low voltage instrumentation across more than 700 utility substations. The CUBEFuse and fuse holder have size rejection features built in, allowing the utility to standardize on the 60 amp fuse holder, giving them flexibility they needed.

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EATON

Powering Business Worldwide

To learn more, visit **www.CUBEFuse.com.**

Innovative Automation Helps Bridge IT/OT Divide for Improved Projects and Performance

Emerson's latest release of the DeltaV automation system brings significant enhancements across software, hardware, and mobile apps to establish a cybersecurity-certified control system with a modern user experience that keeps plant operators more connected, informed, and efficient.

Emerson's newest control system enhancements make project engineering and operations more intuitive, flexible, and secure

As today's industrial manufacturers try to capture the value of IIoT, they are moving toward a more integrated plant environment to make operations more connected and productive. To help organizations accomplish this digital transformation, Emerson has introduced DeltaV™ version 14, a cybersecurity-certified, IIoT-ready control system designed to help organizations achieve Top Quartile performance in capital projects and operations.

Emerson has enhanced every layer of its DeltaV distributed control system—I/O, controller, communications and enterprise layers, and HMI—delivering more efficiency and more secure lifecycle value, all within an advanced certified cybersecure framework.

DeltaV Live Operator Interface - A modern, built-for-purpose operations experience that makes graphic design easy. DeltaV Live provides a world-class operations experience, designed for today's high-performance operator requirements. This highly-customizable Human Machine Interface (HMI) is Emerson's first to natively support HTML5, laying the foundation for universal, cross-platform graphics that are easy to design, configure, and maintain.

Smart Commissioning - Drastically reducing commissioning time and effort, Smart Commissioning streamlines the commissioning of field instrumentation. Automatic binding, device configuration, testing, and documentation eliminate manual work and reduce trips, taking commissioning off a capital project's critical path.

DeltaV PK Controller - Powerful standalone. Easily integrated. The DeltaV PK Controller is designed with flexibility in mind for project execution support and operational efficiency. Built to a smaller footprint, the DeltaV PK Controller delivers the features of a full-scale DCS. Designed to help organizations efficiently achieve the benefits of skids and modular construction, the DeltaV PK Controller can run headless, with a local operator interface, or be easily integrated into a plant-wide DeltaV system.

DeltaV Mobile - DeltaV Mobile allows engineers, managers, and operators to unleash their operations performance potential with easy, secure, on-demand access to manufacturing data—anywhere and anytime.

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EMERSON™

Emerson.com/DeltaV14

EZAutomation

EZAutomation, a division of the AVG Group, is a manufacturer and online distributor of innovative low cost automation products Made in the USA. Such products include HMI/Operator Interface Panels, Programmable Logic Controllers (PLCs), Power Supplies, Sensors, Industrial PCs, Programmable Encoders, Control Transformers, all-in-one HMI-PLC combo units and much more. AVG Automation and its three divisions, Autotech Controls, Uticor Technologies and EZAutomation, have been in business serving the automation industry since 1968, and is proud to be one of the only automation suppliers who continues to manufacture everything in the USA.

Innovation at its best

EZAutomation is always at the fore-front of technology, innovating new concepts based on industrial automation needs. With our new line of EZRack PLC with built in IIoT feature, EZ12 HMIs with built in mounting and user level private labeling, unique integrated EZTouch I/O combo units for small enclosures, Programmable Timers, and DC Power Supplies with a display for voltage, load current and maintenance alerts, EZAutomation has taken industrial automation to the next level. This innovation is why we continue to be awarded Control Engineering's Engineer's Choice Awards year after year.

EZRack PLC

EZAutomation introduced the first ever EZRack PLC/PAC with IIoT ready CPU and MQTT protocol.

Its advanced function blocks, auto tag addressing, EtherNet/IP protocol and built-in simulator makes it very convenient for programming and maintenance.

IIoT boils down to incorporating machine learning, harnessing the sensor data, and machine to machine communications. It acts as a bridge between existing operational technology within a plant and plant database networks. Valuable data can be shared instantly, reliably and securely to improve plant productivity. Vital data can be sent to subscribers in real time, which gives a competitive edge, as data is on the finger tips and strategic decisions can be made instantly.

EZ12 HMI

HMI's just got personal. EZ12 Series has a very high resolution, LED backlit with 65K colors display and a unique built-in panel mounting arrangement. This is the first ever HMI to have user level private labeling feature (Hardware and Software). With its newly designed user friendly software, and a very low cost sleek looking hardware, it's an HMI you just can't ignore.

EZAutomation
Division of AVG

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Fibox Enclosing Innovations — Make Difficult EASY

Fibox is the world leader in non-metallic polycarbonate enclosures; developing both new products and new technologies for today's marketplace. Our enclosures are UL listed and NEMA rated (4X & 6P), manufactured in aluminum, fiber-glass and of course polycarbonate! With a solution for virtually any location, Fibox has you covered.

Ranging in size from 2 x 2 to 32 x 24 inches, with a thousand off-the-shelf variations, which are ready to ship to you with nominal lead time. Why do it yourself? Save time, money, and aggravation with an enclosure that is custom-tailored to your exact needs. Fibox offers precision CNC machining on premises before shipping.

Fibox is a company of firsts, and *"Enclosing Innovations"* is more than just a slogan; it's our past, present, and future.

Fibox was the first to specialize in **injection molded polycarbonate.** This high impact, radio translucent, robust, lightweight, high-performance thermoplastic is easier to work with than fiberglass or metal. Polycarbonate has a broad temperature range, superior resistance to corrosion, and UV. In short, Fibox's WiFi friendly polycarbonate will not dent, rust, crack or bloom like steel or fiberglass.

Fibox also was the first to utilize **Formed-In-Place gasketing**, ensuring a perfectly laid gasket and a dry, dust free (NEMA 4X) environment.

Fibox's **ARCA - JIC** series ushered in a new era in enclosure technology. ARCA is made for the US market in standard JIC sizes, with continual enhancements to the product line including larger sizes, pre-formed knock-outs, and specialized accessories and mounting options.

This spirit of innovation continues with the first genuine plastic enclosing alternative to steel boxes: the **ARCA-IEC**. The ARCA - IEC measures a whopping 32 x 24 x 12 inches, making it the roomiest polycarbonate cabinet on the block!

With a history of firsts, it's understandable to see why Fibox is the leader in enclosing innovations and how Fibox makes difficult easy every day!

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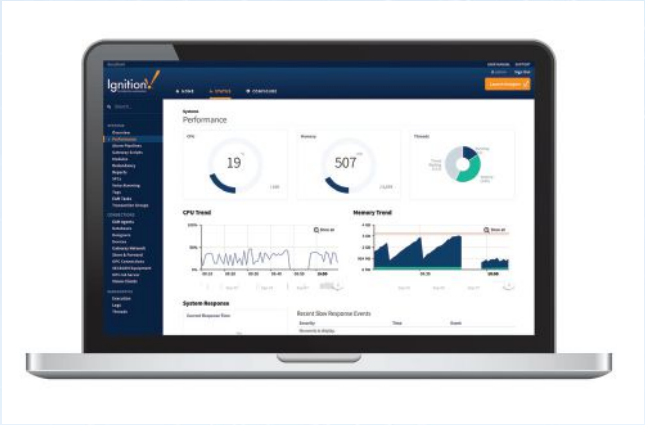
FIBOX
Enclosing innovations

Contact Fibox to learn more: 410.760.9696 | **www.fiboxusa.com** | sales@fiboxusa.com

Ignition: The Unlimited Platform for SCADA and So Much More



Ignition by Inductive Automation®

The Ignition industrial application platform combines unlimited licensing, instant web-based deployment, and the industry-leading toolset for supervisory control and data acquisition (SCADA) — all on one open, scalable universal platform. Ignition is The New SCADA because it solves the major pain points of old SCADA. Now your business can easily control processes, and track, display, and analyze all its data, without limits.

In addition to SCADA, Ignition is a great solution for the Industrial Internet of Things (IIoT), manufacturing execution systems (MES), human-machine interfaces (HMI), alarming, reporting, and edge computing.

Ignition IIoT - This end-to-end IIoT solution lets you easily connect to and push data from thousands of devices across numerous sites through a central MQTT infrastructure to both industrial and business applications.

Ignition MES - Collect all your industrial data, connect to any SCADA or ERP system, and build virtually any MES application. Use Ignition to track production, eliminate downtime, schedule work orders, manage recipes, and more.

Ignition HMI - Rapidly develop high-performance HMIs that optimize operator efficiency. Ignition makes working with HMIs easy, and updates are fast and painless.

Ignition Alarming - Build advanced alarming systems with drag-and-drop ease. Fast to install, easy to use, and infinitely scalable, Ignition is an unbeatable alarming solution at an incredible price.

Ignition Reporting - Easily create dynamic, database-driven industrial reports for a low price. Easily pull together all your data and create any kind of industrial report in any major format and automatically deliver it to anyone.

Ignition Edge - Ignition Edge is a line of lightweight, limited, low-cost Ignition solutions made for embedding into edge-of-network field and OEM devices. Now you can extend data collection, visualization, and system management out to the edge of your network more easily and affordably.

Our Mission

With more than 14 years in the industry and Ignition installations in over 100 countries around the world, Inductive Automation's mission is to create industrial software that empowers our customers to swiftly turn great ideas into reality by removing all technological and economic obstacles.

Steve Hechtman
President & CEO
Inductive Automation

inductive automation

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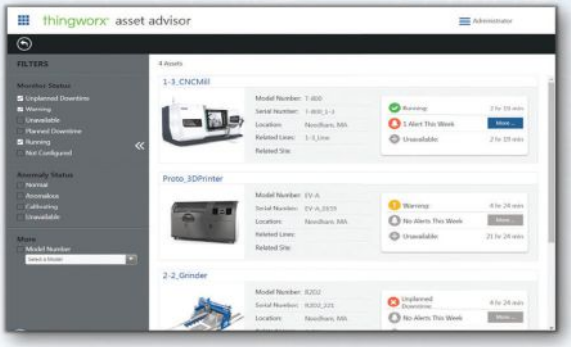
To learn more about what you can do with Ignition, visit: **inductiveautomation.com**

Rapid IoT with Purpose-Built Solutions

The ThingWorx platform is a purpose-built IoT solution offering broad functionality—from monitoring and control, to analytics and augmented reality. To address your industry-specific needs, ThingWorx accelerates time-to-value via Manufacturing Accelerators and provides customized, role-based functionality with Manufacturing Apps. These Apps and Accelerators provide immediate IoT value, while the platform can be expanded for continued ROI as your smart manufacturing projects become more robust.



Data-Driven Decisions, Without Data Overload

ThingWorx Manufacturing Apps provide role-based data for integrated factory floor visibility, proactive issue resolution and data-driven decision-making. 100% web-enabled and accessible via any browser, the Apps are simple and fast to deploy, and provide users with IoT-enabled visibility into equipment KPIs specific to their needs. Available as a free trial with the ThingWorx platform, they provide rapid proof-of-value using real-time data, so users can quickly verify the benefits of ThingWorx before onboarding a more complete platform implementation.

ThingWorx Apps include:

- ThingWorx Asset Advisor: designed to overcome the challenges of low visibility into the health and status of critical assets
- ThingWorx Controls Advisor: designed to overcome the challenges of connectivity errors and critical data loss

Accelerate Your IoT

ThingWorx Manufacturing Accelerators are the proven building blocks for fast-tracking your own customized IoT solutions. Leveraging the capabilities of the ThingWorx Platform, the accelerators are designed to help you overcome the challenges of performance data latency and provide immediate improvements in visibility across the factory.

They accelerate your initial IoT applications, while providing a firm foundation for expanding your smart, connected operations.

Transform Your Operations with a Market-Proven Platform

ThingWorx gives you the power to implement rapid industrial innovation across the factory, including:

- Enhanced visibility into connected system data—improving your service, support and usability
- New revenue streams, business models and opportunities based on newly available, in-depth data
- Increased uptime, efficiency and productivity across the plant floor

ptc

www.ptc.com/MFG

Future-Proof Manufacturing With Smart Plants

How did a power tool manufacturer improve labor efficiency by 10% and utilization rates from 80% to 90%? What about the engineering major who increased operational efficiency by 20% through simulation of material movement? Both these cases and numerous others have found success through one underlying technology—digitalization.

Treading the Digital Path

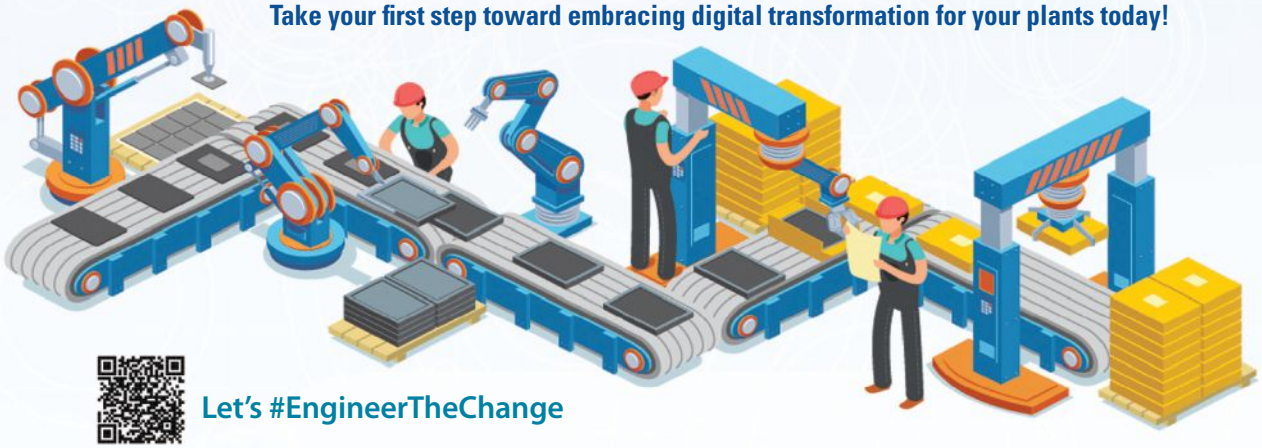
Converting a traditional factory into a smart plant involves a lot of strategic planning and diligent execution, which often require plant operators to:

Walk the LTTS Way

For years now, LTTS has been making manufacturing plants smarter by incorporating technologies like industrial IoT, automation, and cloud computing. We help companies develop connected ecosystems, ensuring that plant owners can constantly monitor and document machine health, production status, and risk assessment without breaking a sweat.

Enhanced productivity, better ROI, higher revenue, and improved efficiency are results companies often report from taking this digital leap of faith.

Let's start a conversation.
Take your first step toward embracing digital transformation for your plants today!



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The best machines and production facilities in the world use Lenze.

About Lenze

Lenze is a global manufacturer of electrical and mechanical drives, motion control and automation technology. As a global specialist in Motion Centric Automation, we offer our customers products, drive solutions, complete automation systems, engineering services and tools from a single source. We are a leading provider of innovative automation solutions for many industries including: consumer packaged goods, converting and printing, automotive, robotics, material handling and logistics, and commercial pumps/fans.

With a global network of engineers, sales representatives, and manufacturing facilities, Lenze is well-positioned to meet the motion control needs of customers worldwide. Lenze Americas, the American subsidiary of Lenze SE of Germany, is headquartered in Uxbridge, Massachusetts, with an assembly and logistics center in Glendale Heights, Illinois. The company's global corporate headquarters is located in Hamelin, Germany.

Lenze Smart Motor – an easy mechatronic solution.

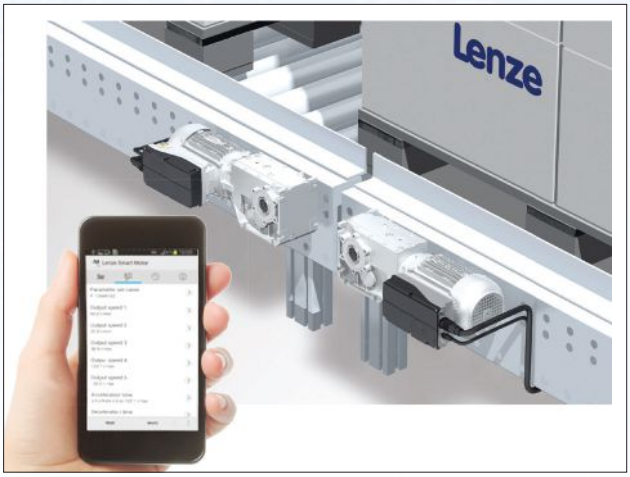
The Lenze Smart Motor reduces the number of different drive versions by up to 70%. This motor works without a contactor or starter; fixed speeds can be set at will; and there are many integrated functions perfect for material handling applications.

The Lenze Smart Motor also meets the strictest energy efficiency requirements and can be operated very conveniently using a smartphone.

New i500 inverter series – compact and modular.

The i500 is Lenze's new inverter series in the 0.33 to 177 Hp (0.25 to 132 kW) power range. The i500 inverters feature a slim design, user-friendliness, and high energy-efficiency. Innovative interface options enable them to run right out of the box; zero-clearance mounting saves cabinet space; and a modular structure adapts to different production configurations. A Lenze Smart Keypad App allows you to diagnose and parameterize the inverter.

The i500 is a reliable and future-proof drive for a wide range of machine applications.



Lenze Smart Motor features a single drive for material handling and logistics applications.

Lenze

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Maple Systems Now Offers PLCs

More to Build On

Maple Systems now offers a complete line-up of Class I, Div 2 PLCs with built-in and expandable I/O. These PLCs share the same configuration software that is used for our HMI+PLC product line, which means you can program your HMI and PLC using the same software.

The analog modules support several voltage and current modes as well as connection to RTD and Thermocouple Sensors to measure temperature.

The FX Series

These fixed models are designed for simple control applications in which a small number of digital or analog inputs/outputs are all that are required. Most models include and RTC (real-time clock) and support for high-speed counters and PWM (pulse-width modulation) output. Although these models do not support the ability to add I/O expansion modules, we provide a wide selection of models so you can choose the right model to meet your needs.

The EX Series

The EX Series of PLCs are expandable from 1 to 16 I/O modules. Several CPU base modules are available with build-in I/O that can be increased at any time by adding I/O expansion modules. The EX Series also features the MLC2 model with Ethernet and the MLC3 model with over 50 MB memory for logic and data storage.

Easy & Familiar Programming

Use Maple's easy-to-use configuration software to program your PLC in native ladder logic or any IEC61131-3 programming language. These PLCs support communications with Maple's HMI+PLC and popular HMI lines, native Modbus RTU (serial), and Modbus TCP/IP (Ethernet models only). And with support for major PLC manufacturers (Allen Bradley, GE Fanuc, Omron, Siemens, and more), easily add a Maple Systems PLC to your existing control system for additional I/O.

Maple Systems is celebrating 35 years in the automation control industry. We have built our reputation on providing quality products, free tech support, fast shipping, and excellent pricing. Visit **www.maplesystems.com** today to learn more about Maple's latest product offerings.

Maple Systems INC.

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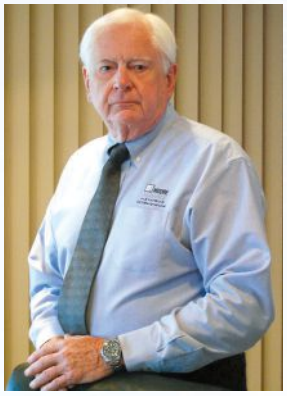
Moore Industries Celebrates 50 Years Providing Innovative Products to the Process Control and Automation Industry

Since 1968, Moore Industries has been proudly serving process manufacturing businesses and fortune 500 companies in oil, gas, mining, chemical, power generation, water/waste water treatment, pharmaceutical, food, beverage, consumer packaged goods, semiconductor, and biotechnology industries. "After working in the instrumentation industry for a few years, I saw a need for tough, reliable, noise-resistant signal conditioners," says Mr. Moore. Moore Industries has grown from three employees in California to offices worldwide in the United States, Australia, Belgium, China, the Netherlands, and the United Kingdom providing rugged and reliable products including alarm trips, remote I/O systems, process controllers, I/P and P/I converters.

Today Moore Industries is an award winning company that carries on the original mission of making tough and reliable products such as HART interface devices, complete temperature transmitter assemblies and elements, signal conditioners and isolators with a rapidly expanding line of IEC 61508-certified Functional Safety devices. As a world leader in the design and manufacture of interface instruments for industrial process control, system integration, and factory automation, the company's success would not have been possible without loyal customers. Customer relationships are the primary focus and Moore Industries will continue to provide nothing less than the best quality in process industry products and exceptional services.

Scott Saunders, CEO, and Leonard W. Moore with the ISA award.



Leonard W. Moore, Founder

Appreciation for customer service and innovation over the years has led to numerous awards and recognition including multiple Control Engineering Product Recognition awards and Automation Excellence Awards. In 2009, Mr. Moore was awarded one of the process industry's highest honors, ISA Honorary Membership. He also holds a lifetime membership with IEEE.

"Over the years, we have transformed the company's analog instrumentation lines and solutions into microprocessor and software based smart instrumentation and control products. An overwhelming amount of the company's long-term success and tenure within the industry belongs to our devoted and hardworking employees," comments Scott Saunders, President and CEO.

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MOORE INDUSTRIES WORLDWIDE

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Nexans gives you the confidence to make the connection

Industrial Ethernet is the technology of the future on the factory floor. It enables convergence to the office and to the internet, which is impossible over traditional, often piecemealed bus technologies. Nexans' industrial Ethernet solutions help improve productivity and profitability by avoiding, eliminating, and minimizing risk, and ultimately achieving 100% uptime.

The Fourth Industrial Revolution

We are in the midst of the fourth industrial revolution, characterized by the introduction of cyber-physical systems. A cyber-physical system is a mechanism controlled or monitored by computer-based algorithms tightly integrated with the internet and its users. Reliable connections between the machines, the people, and the internet are, in a word, everything. However, one bad connection can mean the flow of information is disrupted, which could have devastating results on your operation and your bottom line.

Nexans gives you the confidence to make the connection.

Superior Product Performance

In the field of industrial cabling solutions, Nexans offers a complete range of products that provide improved reliability and reduced cost of ownership.

Nexans' solutions are run through a battery of vigorous mechanical testing, followed by data transmission testing to ensure your IP traffic will be protected. Nexans Industrial Solutions are built to withstand even the most demanding harsh conditions. Our comprehensive solutions include:

Bulk Copper Cable

- Cat 5e, Cat 6, and Cat 6A
- Two-pair and-four pair products
- Unshielded products available
- Shielding with foil (high frequency) and braids (low frequency)
- TPE and PVC jackets
- Stranded and solid conductors
- 23AWG and 24AWG
- 600V AWM rated

Bulk Fiber Cable

- OM1, OM2, OM3, OM4, and single-mode
- Loose Tube constructions up to 432 fiber counts
- Tight Buffer constructions up to 144 fiber counts
- Jacketing in PVC, PVDF, LSZH, MDPE, and PUR
- Indoor/Outdoor rated

Field Installable Connectors

- M12 and RJ45 variety
- IP67 rated
- Shielded and unshielded RJ45 connectors

Industrial Cordsets

- M12 and RJ45 copper assemblies
- IP20 and IP67 rated available
- Shielded and unshielded

Fiber Assemblies

- LC-LC and MPO-MPO Assemblies

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Nexans

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It's EPIC! *groov* EPIC: the world's first Edge Programmable Industrial Controller

The completely new *groov* EPIC® brings the future of automation to the present by combining guaranteed-for-life I/O, real-time control, local and remote HMI, and industrial/IT data exchange in a secure edge-of-network industrial system.

The flexible Linux®-based controller with gateway functions offers a high-resolution touchscreen, two independent Ethernet network interfaces, USB and HDMI ports, and software including control programming, device-independent HMI, Node-RED for simple data flows, and Ignition Edge® from Inductive Automation® for OPC-UA drivers and efficient MQTT/Sparkplug communications.

For automation projects

groov EPIC's high-resolution touchscreen lets you configure and troubleshoot I/O and networking in the field or remotely.

Touch an I/O module and see its specs, wiring diagrams, and current values. Use your custom-built HMI on the touchscreen to securely monitor, control, and get data from systems, equipment, online services, company databases, and more.

With UL Hazardous Locations approval, ATEX compliance, and a wide -20 to 70 °C operating temperature range, *groov* EPIC is ready for tough environments.

For industrial internet of things (IIoT) projects

Based on open automation and internet standards, *groov* EPIC handles connectivity to both operations technology (OT) and information technology (IT) networks and protocols, opening new options for tracking, storing, and visualizing data.

In addition to included software, optional secure shell access (SSH) to the real-time, open-source Linux OS lets you develop your own custom applications.

"*groov* EPIC is a response to industry requests to more wholly integrate IT and OT technologies, simplify development and deployment, and provide a platform for long-term growth now and well into the future," notes Mark Engman, Opto 22 CEO.

Mark Engman, CEO

About Opto 22

For 45 years, Opto 22 has manufactured high-quality automation equipment based on open standards and innovation. All Opto 22 products are manufactured and supported in the U.S.A. Most SSRs and I/O are guaranteed for life, and product support is free.

Learn more about *groov* EPIC on our website, Opto22.com, or contact our pre-sales engineers.

OPTO 22

The Future of Automation.

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POSITAL Kit Encoders: Closed-Loop Rotary Position Feedback for Servomotors, Stepper Motors and Rotating Machinery

Control systems in robots, production machinery, autonomous vehicles etc. often require closed-loop feedback mechanisms to achieve precise control over the position of mechanical components. POSITAL's kit encoders are designed to provide the manufacturers of servomotors, stepper motors and other machines with rugged, accurate and cost-efficient tools for building rotary position feedback into their products. They are based on POSITAL's successful self-contained magnetic rotary encoders. Now however, the core components of these instruments are available as separate assemblies that can be readily integrated into other products.

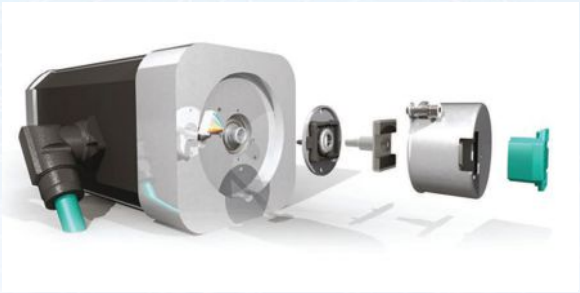
Non-Proprietary Single-Cable Interfaces Reduce Costs, Increase Versatility

The electronic interface for these encoders is based on non-proprietary BiSS Line, BiSS-C and SSI communications standards. Unlike proprietary, vendor-specific interfaces, these open-source standards are supported by many manufacturers of sensors, PLCs and motion controllers, freeing users from a "locked-in" relationship with a single supplier. The **BiSS Line standards** support a **single cable** approach to motor connections, with power and control wires combined in a single cable.

High Performance with Low Maintenance

Compared to analog resolvers, POSITAL kit encoder components provide improved accuracy and multi-turn measurement capabilities. Their output is digital, avoiding the need for A/D converters in the control system. Compared to optical disk encoders, POSITAL's magnetic encoders are less costly, less vulnerable to contamination from oil or dust and more resistant to shock and vibration.

Multi-turn absolute position measuring capability is based on an electronic rotation counter powered by the company's well-proven Wiegand-effect energy harvesting technology. This system is self-powered, so rotation counts are always accurate, even if rotations occur when control system power is unavailable. No backup batteries required!



Efficient Installation

POSITAL magnetic kit encoders don't require near-cleanroom assembly conditions and are easy to incorporate into normal manufacturing processes. A built-in self-calibration capability can be used to compensate for small sensor-to-shaft alignment errors occurring during assembly. The electronic components, including Hall-effect sensors, a 32-bit microprocessor and the Wiegand-wire energy harvesting system, are all packaged in a convenient 36 mm diameter, 24.2mm deep unit. For servomotors with magnetic brakes, magnetic shielding is available to isolate the Hall-effect sensors from external magnetic fields.

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POSITAL
FRABA

Watch the video: **https://www.youtube.com/watch?v=eKoEgfFR1H8** | Visit **www.posital.com**

How ISO 9001:2015 Certification Benefits Customers

By Thomas Foy - Radwell Global Corporate Training & ISO Manager

ISO 9001:2015 certification is a positive achievement for an organization. This achievement is very important for a company as well as the customers it services.

For Radwell International, there were certain key points that we recognized as major external benefits to our customers upon achieving ISO 9001: 2015 certification.

- **Improved Quality and Service**—By adhering to the ISO 9001: 2015 standard we enhance all aspects of the products and services we provide for our customers, from the level of repairs we offer, testing capabilities we provide, and the effective turnaround of new, surplus, and repairs we offer. This allows us to provide a higher level of customer service throughout our organization.
- **Annual and Independent Audits**—we provide annual audits to insure compliance with ISO 9001: 2015 standards and best practices. We also have an independent Certification company provide 2 and 3 day audits to give us additional perspective and provide third party expertise to allow us to maintain our ISO Certification.
- **Quality Review and Testing Capabilities**—by offering thorough and extensive quality checks and thorough testing, we provide our customers with exceptional products and services, which provide peace of mind, confidence, minimal returns, and the desire to work with Radwell on a regular basis.
- **Reliable Production Scheduling and Delivery**—ISO standards allow our customers to have realistic expectations with our Repair lead times, and confidence in our New and Surplus turnaround time. This also allows us to pinpoint delivery times with existing Inventory stock items.
- **Minimize Errors**—ISO standards provide our customers with minimal errors for repairs, which enhance customer confidence. This also holds true for items that we have in stock, and also for items we outsource when necessary. Customers can count on Radwell to cover all their repair, surplus and new product needs.

RADWELL® INTERNATIONAL, INC.

To learn more about Radwell International's ISO 9001:2015 Certification visit **https://info.radwell.com/iso-9001-certification**

New Drive and Maintenance Management Solutions from SEW-EURODRIVE

CDM® Maintenance Management

SEW-EURODRIVE now offers a full complement of drive maintenance services. Our CDM® Maintenance Management service provides an online portal and complete overview of your entire stock of drive components, condition of your units, drive usage, and service details. With 24/7 online access, CDM removes the headache of managing your maintenance and inventory.

Pick-Up Box Service

Let SEW-EURODRIVE be a part of your maintenance team to free up your crew for other tasks. This new service provides a dedicated on-site Pick-Up Box, along with scheduled pick-up, repair, and return of your drive units. Each unit is examined by an experienced SEW-EURODRIVE service technician. Service or repairs are completed after approval.

MOVIGEAR®

The MOVIGEAR® Mechatronic Drive System for horizontal materials handling from SEW-EURODRIVE sets new standards in terms of efficiency and functionality. MOVIGEAR® combines the gear unit, motor and electronics within one highly reliable, efficient, and hygienically designed unit. Not only does independent research prove that MOVIGEAR reduces total start-up cost and annual operating expenses by 20-30%, but actual installations have seen even higher savings…by as much as 50%!

DRC Electronic Motor

The DRC electronic motor provides an ultra-efficient motor and electronics package for those SEW gear units already installed in your system. Like MOVIGEAR, the DRC electronic motor consists of a permanent-field synchronous motor with integrated drive electronics in a completely enclosed housing. Step up to IE4 efficiency — the next level beyond premium.

About SEW-EURODRIVE

Engineering excellence and customer responsiveness distinguish SEW-EURODRIVE, a leading manufacturer of integrated power transmission and motion control systems. SEW-EURODRIVE solutions set the global standard for high performance and rugged reliability in the toughest operating conditions. With its global headquarters in Germany, the privately held company currently employs over 16,000 employees with a presence in 48 countries worldwide. U.S. operations include a state-of-the-art manufacturing center, five regional assembly plants, more than 63 technical sales offices and hundreds of distributors and support specialists. This enables SEW-EURODRIVE to provide local manufacturing, service and support, coast-to-coast andaround the world.

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SEW EURODRIVE

Sierra is Single Source Provider for All Flow Energy Management Applications

A global leader in flow measurement and control for 45 years, Sierra Instruments designs and manufactures fluid flow measurement and control solutions for customers spanning global industries as diverse as scientific research, oil & gas, energy and facilities management, clean energy, aerospace, and biotech. Sierra has always been rooted in the tradition of being the global leader in thermal dispersion mass flow meters for gas mass flow measurement.

This legacy was solidified in 2012 with the launch of the QuadraTherm® four-sensor thermal mass flow meter, the most accurate thermal mass flow meter on the market with accuracies +/- 0.5% of reading. To continue this tradition of innovation, in 2017, we launched the "Big-3™", which includes thermal, vortex, and ultrasonic flow meter technologies. Now engineers have one complete flow energy management solution for any gas, liquid, or steam flow application.

Get ONE Complete Flow Energy Management Solution-All Backed by a Team of Experts

With the Big-3, engineers can rely on one single source supplier and one team of flow experts, not ten different instrumentation companies , for product specification, commissioning, and lifetime engineering support for any gas, liquid, and steam flow metering application-all designed, manufactured, calibrated, and supported by Sierra USA. This marks an innovative approach and improved process for specifying, purchasing, and supporting flow instrumentation.

ONE Integration & Automation Solution

Perfect for plant automation, the Big-3 also share common firmware and software for easy integration, set up, and serviceability, enabling operators to leverage their knowledge between the different platforms.

- Software apps gives plant engineers and managers the ability to mine and analyze data quickly to make effective productivity decisions
- All patented (thermal, vortex, and ultrasonic) sensors provide unparalleled accuracy, extensive flow knowledge through multivariable functionality
- Investment in calibration assets for water, steam, and gas calibration-all at Sierra USA

Learn more about how to efficiently manage your flow energy at **sierrainstruments.com/one**

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Unlock device-level data and reduce control costs with Turck automation components

In any operation, engineers and OEMs have to weigh costs vs. capabilities. From sensors and connectivity to fieldbus technology devices, Turck delivers and designs components to solve this ongoing challenge.

Minifast HD cordsets offer an ATEX-approved connector in a completely assembled cable package.

Control costs can be among the highest expenses in automation. While PLCs fundamentally changed the industrial control landscape, today the costs to add I/O points and license required third-party software are often a burden.

To reduce these costs and provide device-level control, Turck developed its Field Logic Controllers (FLCs) powered by ARGEE technology.

ARGEE empowers manufacturers to add logic to compatible I/O devices without a PLC. Accessed via an HTML5-compatible web browser, this software transforms I/O devices into FLCs for use as:

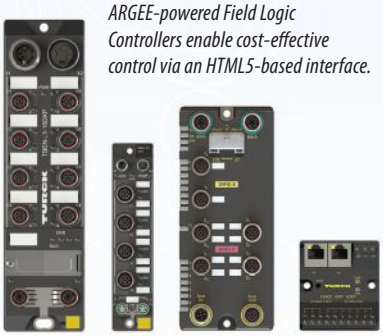
- Standalone logic controllers: FLCs perform all logic as a standalone application without a PLC.
- Local backup for a PLC: If FLCs lose communication with the PLC, the devices can take over and either shut down or maintain the process.
- Partners for PLC processing: FLCs can monitor an application and send defined variables and updates back to the PLC.

As FLCs revolutionize automation control, technology and design advances drive new solutions in sensors and connectivity.

Uprox3 IO-Link sensors offer the market's longest sensing distances for all metals.

Point-to-point communication via IO-Link technology is one breakthrough, offering advantages in signal quality, parameterization and diagnostics, and device-level data insights. Turck continues to expand its IO-Link product line with these benefits in mind. Its Uprox3 IO-Link sensor combines IO-Link capabilities with the longest Factor 1 sensing ranges on the market for unparalleled performance.

While internal technology shapes sensor capabilities, connectivity solutions are undergoing a design shift. With increasing demand for reliable solutions in harsh applications, many Turck cables and connectors feature rugged overmolds and advanced plastics and stainless steel that stand up to these environments. These design upgrades improve reliability in applications where vibration, temperature, ingress and pull strength threaten performance.



ARGEE-powered Field Logic Controllers enable cost-effective control via an HTML5-based interface.

TURCK

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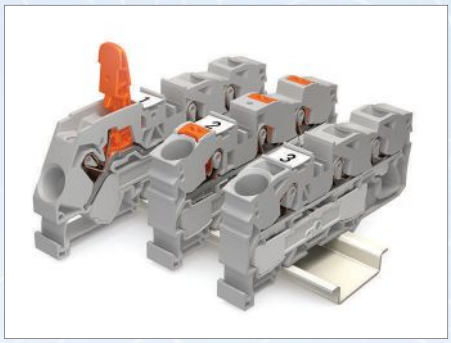
WAGO Innovations Continue to Lead the Way Into the Future

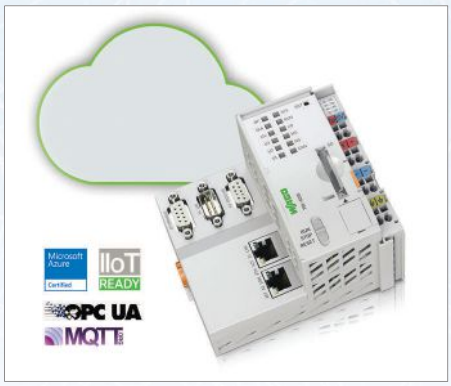
WAGO Corporation provides innovative Interconnect, Electronic Interface, Terminal Block and Automation solutions. Equipped with CAGE CLAMP® Spring Pressure Connection Technology, WAGO products are user-friendly, vibration-proof and maintenance-free. From terminal blocks to PLCs and more, our compact products deliver safe and reliable solutions for any factory, process or building application.

Innovations include:



TOPJOB® S Terminal Blocks – Now with Lever and Push-button

The TOPJOB® S family, with push-in CAGE CLAMP®, was the first to introduce push-in wiring for rail mount terminal blocks. Since its introduction, new features and benefits have been added every year. Taking yet another leap forward, the family now offers levers and push-buttons for convenient and intuitive wire termination while maintaining the vibration-proof, gas-tight, corrosion and thermal-cycling resistant connection the industry has come to expect from us. Learn more: **www.wago.us/leverTB**



Move Securely Into the Cloud with PFC Series Controllers

Using a simple MQTT software upgrade, any WAGO PFC Series controller can be transformed into an IIoT controller with cloud connectivity. TLS encryption allows you to securely interface with existing controls via multiple onboard fieldbus gateways. Learn more: **www.wago.us/pfccloud**

Break Tradition with Electronic Circuit Breakers

EPSITRON® single-channel ECB's are 6 mm wide, which is up to 66% smaller than traditional circuit breakers. Local and remote configuration capabilities and a more reliable trip curve are a few things that also set them apart from thermal magnetic circuit breakers. Learn more: **www.wago.us/whyECB**

To see our company video, please visit : **www.wago.us/company-video**

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WAGO

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High speed servo dispensing systems achieve precise, accurate dispensing results, while increasing productivity

Complete YRG Servo Dispensing System

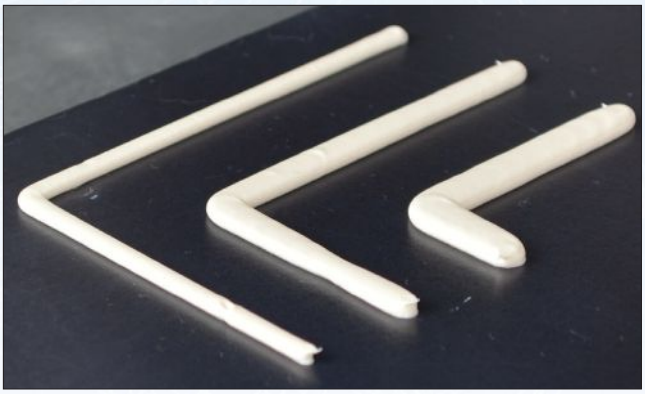
Dispensing systems can be relatively complex due to many variables. Set up time to achieve a consistent result can be difficult and challenging. Changing conditions, such as temperature, humidity, material viscosities, and fluctuating air pressure also contribute to production inconsistencies. With traditional dispensing systems, robots and servo arms speeds are reduced to meet linear velocities that achieve the required bead height, width and volume, based on the tightest corner of the overall application.

YRG Servo Dispensing system (YSD) allows customers to have total control and flexibility to adapt to these constantly changing variables, along with the ability to increase production throughput. The system utilizes a Yamaha XYZ Cartesian Robot with its interpolated servo motor and 3rd party auger driven pump.

With the integrated controls of the YRG servo controlled dispensing system an accurate precise amount of material can be programmed to dispense the right amount of material, at the right rate, at the right time, while monitoring other variables and responding to those variables as conditions change. Due to interpolated motion in Yamaha's RCX340 controller, the system has the ability to automatically change the speeds as the robot travels through its set of programmed points. This feature allows the robot to move extremely fast on long runs and very slowly in tight corners while maintaining a consistent and uniform bead width of dispensed material.

This means that customers no longer have to run slow speeds due to YRG's ability to dispense material at variable rates with its integrated servo motor rotating an auger-style dispensing pump.

Traditional material dispensing systems use pump and pail equipment to provide bulk material to an air pressure regulator and pump valve. With these components, clean, filtered air pressure can be adjusted up or down depending on the viscosity of the material and environmental conditions such as temperature and humidity. Sometimes the same material can change slightly from pail to pail along with other variables; therefore, operators constantly adjust air pressure as these conditions change.



90° angles are easily achieved with the YSD.

A YRG high speed servo dispensing system does not rely on air pressure and control valves to maintain material flow and can be easily programmed to run fast on long stretches, slow-down in corners, increase the pump speed in heavy amount areas, run in reverse to provide a suck back and provide flexibility to adapt to changing conditions. Having more control over the entire dispensing system provides precise, accurate and consistent control in order to increase productivity and quality, while lowering maintenance and costly rejects or rework.

YRG™ ROBOTICS YAMAHA

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TDK-Lambda Americas Power Blog Exceeds Over 1,000,000 Page Views

Over ten years ago, TDK-Lambda Americas started a **Power Blog** to address frequently asked customer questions being answered by Tech Support. Initially hosted on Google's Blogspot, the articles are now also accessible on the company's home page [**www.us.tdk-lambda.com/lp**] with convenient pdf downloads.

We invite you to view the ongoing list of Blog topics at https://bit.ly/2IjoCTq

The blog addresses a wide range of topics — 105 actually — ranging from upcoming changes to safety standards, to more simple questions such as *"why does the power supply rating label say 100-240Vac?"*

The content is deliberately kept as simple and as brief as possible to appeal to engineers looking for quick answers, without having to read through multiple pages of lengthy documents in an instruction manual. As the content grows in size, technical support calls and emails can be rapidly and thoroughly responded to by simply referencing a link where the customer can be guided by straight-forward answers and/or instructions.

How many more articles can TDK-Lambda write on power supplies and DC-DC converters? One of our main authors has twelve new subjects on his whiteboard, so we do not anticipate the **Blog** stopping any time soon!

TDK

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Don't design your equipment around an actuator. Get the actuator you need with Compact!

Compact Automation is North Americas leader in high value actuation solutions for original equipment manufacturers. We make complex automation simple by offering a vast array of highly customized actuation products. With more standard options than any company in the industry, as well as the ability to produce fully custom products at any volume, you can always get the exact product you need, when you need it.

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NEW PRODUCTS FOR ENGINEERS

Remote monitoring system »

The Sentinel system from Sensaphone uses cloud technology to provide supervised 24/7 remote monitoring of environmental conditions and unattended equipment at facilities, and helps operators easily access the status of all conditions in real time from any device and at any time. User-friendly cloud functionality lets facility managers change settings, disable alarms, and readjust temperature limits from the Sensaphone iPhone (Apple)/Android (Google) app. The system also makes it easy to calibrate temperature sensors. If the communication link is interrupted, an alarm indicates that the Internet connection is lost or that a cellular communications problem exists.

Sensaphone, www.sensaphone.com Input #200 at www.controleng.com/information

Fieldbus gateway series »

Advantech's Fieldbus Gateway EKI-1242 series are designed for protocol extensibility and seamless integration with existing network devices. The series support widely used industrial protocols such as Profinet, EtherNet/IP, and EtherCAT for field device integration. They are designed to help plant managers create a seamless interconnection between industrial protocols, making use of existing field devices more flexible. Also, they efficiently connect field devices to Ethernet network infrastructure, providing redundant and management functions for central management. They also allow the connection of devices with different protocols for diagnosis, analysis, and management.

Advantech, www.advantech.com Input #201 at www.controleng.com/information

High-temperature position sensors

NewTek Sensor Solutions' HT-1000 Series of extreme high-temperature linear position sensors are designed for harsh and rugged environments such as industrial equipment found within power plants, engine control systems, and autoclaves. These ac-operated linear variable differential transformers (LVDTs) are constructed of special high-temperature materials to withstand temperatures up to 1,000°F (538°C). The HT-1000 provides a ratiometric output for reduced thermal error that results in an extremely low thermal sensitivity over a wide temperature range. In addition to offering linearity of ±0.5% of full range, the HT-1000 offers unlimited mechanical and electrical life as well as high reliability due to the absence of friction and contact between the core and the coil.

NewTek Sensor Solutions
www.newteksensors.com
Input #202 at www.controleng.com/information

Signal splitter carrier

Acromag's uBSP carrier is used with plug-in Acromag microBlox (uB) input modules to build a flexible signal splitter/duplicator. Users can select from a variety of modules to match the input signal type for conversion to two proportional process current or voltage outputs. A third auxiliary voltage output is driven directly by the module. High-voltage isolation separates the input from each output circuit. The isolation protects from surges, reduces noise, and eliminates ground loop errors. Featured software is designed to simplify input/output (I/O) range scaling, calibration, and advanced signal processing capabilities. The carriers also are designed to withstand harsh industrial environments to operate reliably across a wide temperature range with very low drift.

Acromag, www.acromag.com
Input #203 at www.controleng.com/information

research 2018

Career & Salary Research

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Turning Research into Insights Makes for Better Business Decisions

Control Engineering career and salary research shows that engineers are getting paid more and a greater percentage expect to get increases in 2018 while technical challenge and feeling of accomplishment continue to rank higher than financial compensation for job satisfaction.

With the average respondent being in their 50's, the average base salary earned by 50- to 59-year-olds was $104,482, and the average bonus received in 2017 was $11,102 – for a total take-away of $115,585. The top three factors that impact end users' satisfaction towards their jobs are the level of technical challenge, feelings of accomplishment, and financial compensation.

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www.controleng.com/2018SalaryReport

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Flowmeter fits industrial blower and dryer applications for better zone control

Engineers responsible for the efficient operation of industrial air blowers and dryers used in raw materials production will find the ST50 Mass Flow Meter Series from Fluid Components International (FCI) provides precision measurement of air to increase the efficiency of their systems. Industrial air blowers and dryers are necessary in a wide range of materials process control applications. The installation in process control loops of industrial air blower and dryer systems provides highly accurate hot air flow rate monitoring. The use of mass flow meters ensures precise rate of flow measurement and totalized flow measurement for zone control and overall system operational efficiency.

Fluid Components International (FCI), www.fluidcomponents.com Input #204 at www.controleng.com/information

Computer-aided engineering helps mechatronics applications

Cofaso software's eSchematic is a computer-aided engineering (CAE) software designed to allow the user to design schematics with a mouse wheel. Executing fully automated project engineering is extremely difficult for graphics oriented computer-aided design (CAD) software. Systematic information management saves time and money. The software is designed for mechatronics projects, machine builders, and integrated control panel manufacturers. It has an interface in multiple languages.

Cofaso Software, www.cofaso.com
Input #205 at www.controleng.com/information

Thermal mass flowmeter

Fox Thermal Instruments' Model FT4X thermal mass flowmeter is ideal for industrial process applications. It features a data logger for recording flow rate, totals, and other events and alarms. Model FT4X Data Logger gives information on the meter's settings and functionality. Other features include advanced direct digitally controlled sensor technology, three onboard gas selection menus, an isolated 4-20 mA output configured for HART communication, an isolated open collector pulse/alarm output, and remote switch input. Applications include chemical, energy, oil and gas, and food and beverage.

Fox Thermal Instruments, www.foxthermal.com
Input #206 at www.controleng.com/information

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Jalal Bouhdada, Applied Risk via ISSSource

Six best practices for implementing and securing IIoT products

The practice of "securing by design" can help companies protect against potential cyberattacks on Industrial Internet of Things (IIoT) products.

Benefits of Industrial Internet of Things (IIoT) technology are undeniable. Business value is extracted from a myriad of connected sensors and devices via cloud computing, analytics, and artificial intelligence (AI) within industrial processes. While chasing the potential benefits of IIoT technology, the challenges of digitization have become apparent. From the personal damage of data harvested illicitly from social media networks to large scale damage caused by ransomware attacks on industry and governments, it is clear the benefits of the fourth industrial revolution cannot be reaped without accepting cyber risks. Companies must protect against risks. with "securing by design."

IIoT device risk

Many IIoT devices used in industrial environments such as water, oil, gas, chemical, and manufacturing plants have been deployed with multiple security weaknesses and vulnerabilities.

The even more serious consequence of increased IIoT deployments is the blurring of boundaries between operational technology (OT), which controls the physical hardware of an industrial enterprise, and information technology (IT).

This results from the desire to improve remote monitoring and data gathering from industrial control systems (ICS) and OT. Providing network access to these systems has led to an increasing number of instances in which systems designed for monitoring, control, and safety of infrastructure have become exposed to internet-based attacks designed to disrupt critical infrastructure within industrial processes for commercial or political gain.

Securing the IIoT

The merging of OT and IT is inevitable and industrial facilities should take steps to mitigate the risks of using IIoT products. Adopting industry best practices will reduce risks. Follow this six-point checklist for basic security when implementing IIoT products. Consider these items at the start of the planning process to help identify and counter potential IIoT threats:

1. **Secure interfaces:** Insecure interfaces can result in data manipulation, loss, or corruption; lack of accountability; denial of access; or device takeover.
2. **Update software and firmware regularly:** It is crucial IIoT devices perform updates regularly to protect against the latest threats, and that cryptographic checks are implemented to ensure updates come from a trusted source.
3. **Control access:** Strong passwords, the protection of credentials, and separation of roles must be ensured to prevent compromising a device or a user account.
4. **Secure the network:** Only necessary ports should be available and exposed. Insecure network services may be susceptible to a variety of attacks, including denial of service (DoS), which renders a device inaccessible.
5. **Eliminate backdoors:** No IIoT device should have undocumented backdoors or hidden functions that an attacker could exploit.
6. **Configure for security:** Attackers often exploit a lack of granular permissions to access data or controls. Security hardening, encryption of data in transit, and logging security events can counter this risk.

These six points, combined with strict lifecycle management regimes and regular, constant testing can give firms the security, safety, reliability, resilience, and privacy controls needed to deploy IIoT solutions effectively. Manufacturers, end users, and integrators must adopt a "secure by design" mindset that anticipates and mitigates potential threats at every stage of an IIoT product's lifecycle.

Overlooking any of the six points on the checklist can leave an IIoT solution at risk of being exploited as well as put other systems at risk. **ce**

Jalal Bouhdada *is founder and principal ICS security consultant at Applied Risk. This article originally appeared on ISSSource.com, a CFE Media content partner. Edited by Chris Vavra, production editor,* Control Engineering, *cvavra@cfemedia.com.*

More INNOVATIONS

KEYWORDS: IIoT, cybersecurity

Manufacturers and end users should focus on securing Industrial Internet of Things (IIoT) products.

Best practices include software and firmware integrity and no security loopholes in an IIoT device.

Strict lifecycle management regimes and constant testing are needed.

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What additional things need to be done to improve IIoT security on the plant floor?

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