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NOVEMBER 2022

Systems Integration

Reducing Pump Management Time

TSN and Industrial Robotics

Specifying Control Valves for Severe Service

IPC for Temperature Measurement

Flexible Feeding for a Smart Production Line

In This Issue

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Introduction

End users, especially those who are new to digital transformation, rely on system integrators to be the experts in automation best practices and applying new technologies. System integrators are responsible for educating their clients regarding what is possible and how they stand to benefit. Their other role is being the implementor of these latest technologies. System integrators who understand their clients' business objectives can provide guidance about the opportunities that are available to them through digital transformation.

In this issue of *InTech FOCUS*, you will find case studies on temperature measurement and pump management; articles on severe service control valve specification and time-sensitive networking (TSN), and stories on robotics. *InTech* magazine is the official publication of ISA—The International Society of Automation. It is published six times per year. *InTech FOCUS* is its counterpart, brought to you in conjunction with Automation.com.

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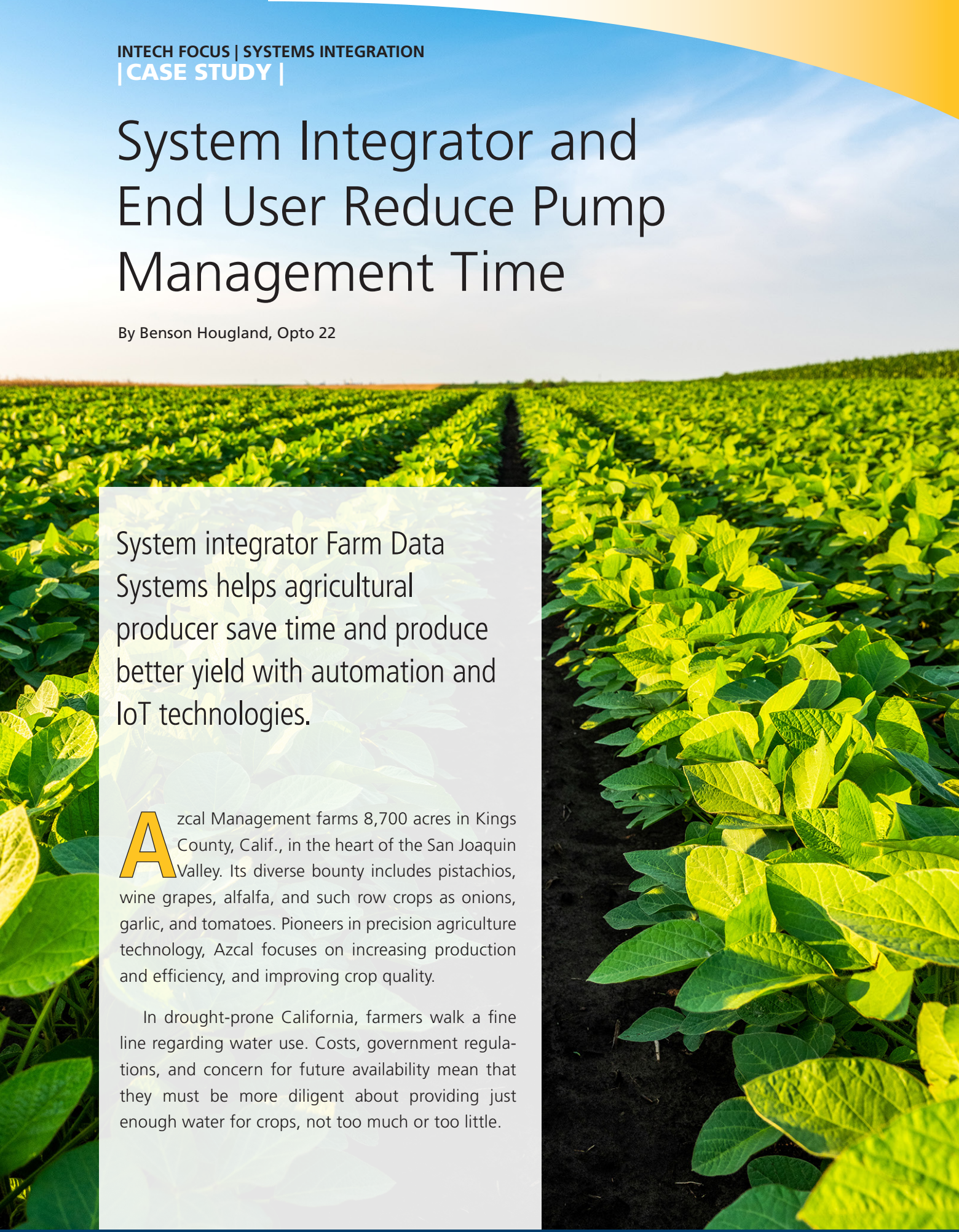
System Integrator and End User Reduce Pump Management Time

By Benson Hougland, Opto 22



System integrator Farm Data Systems helps agricultural producer save time and produce better yield with automation and IoT technologies.

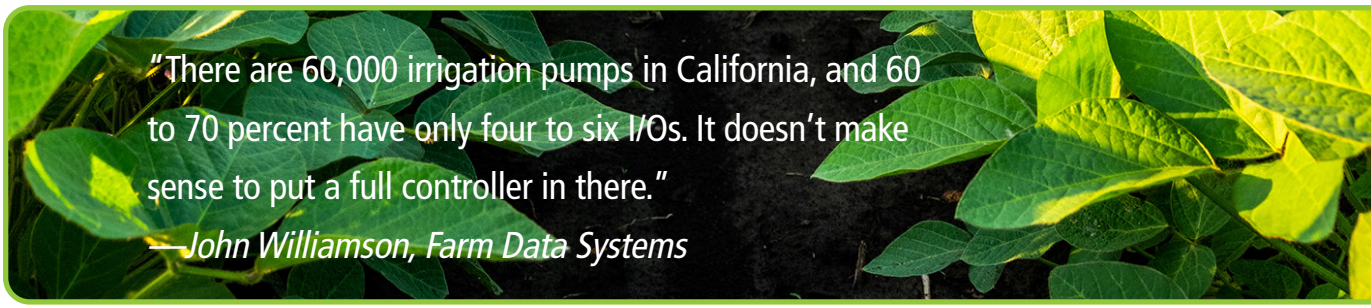
Azcal Management farms 8,700 acres in Kings County, Calif., in the heart of the San Joaquin Valley. Its diverse bounty includes pistachios, wine grapes, alfalfa, and such row crops as onions, garlic, and tomatoes. Pioneers in precision agriculture technology, Azcal focuses on increasing production and efficiency, and improving crop quality.

In drought-prone California, farmers walk a fine line regarding water use. Costs, government regulations, and concern for future availability mean that they must be more diligent about providing just enough water for crops, not too much or too little.

Figure 1. All Azcal wells and irrigation filter stations are equipped with VFDs and flowmeters.

The problem

One of the Azcal ranches has 12 deep-well pumps with variable frequency drives (VFDs) (figure 1) feeding a single mainline (figure 2) that serves a 4,000-acre ranch just south of Lemoore, Calif. Monitoring and controlling these pumps used to be a full-time job for farm managers Jake Sheely and Marty Rhoads. It took about seven hours throughout each day to drive around the ranch and make the needed micro-adjustments to pumping and irrigation systems.



Their monitoring was vital to ensure that system pressures and flows were within range and that pumps were operating efficiently. With four or five well pumps running simultaneously, Sheely and Rhoads had to be diligent to avoid both low- and high-pressure events. This often required them to switch wells based on farming needs. The wells must be kept in operation but not be overdrawn. A drop in the flow rate would mean the well was overdrawn, and if air was sucked into the pump, the well could require thousands of dollars to repair.

In addition, like many growers, they also suffered from power failures and incoming voltage spikes. It could be several hours before they realized a pump was no longer running or had burned up. The time involved in manual monitoring and control was just too much, so Azcal looked for a simple way to automate its water management and track pumping events for monthly water accounting.

Azcal interviewed several agricultural technology providers. They tried proprietary tools designed for pump control, but although these worked for one pump and 40 acres, none of them could integrate everything at scale. In addition, there was limited support for remote or sophisticated proportional-integral-derivative (PID) loop control.

Discouraged, Azcal was dubious when Farm Data Systems (FDS) in Madera, Calif., approached them with new technology. However, no one had been able to deliver what they needed thus far, and FDS owner and president John Williamson had worked on projects for them with a previous company, so they were willing to listen.

The solution

What Azcal needed was a controller at each well pump that was fully integrated with existing VFDs and would allow them to remotely start and stop pumps as well as make micro-adjustments to either the speed or the pressure setpoints. Reliable monitoring of flowmeters and incoming voltage was also a must. FDS responded with an integrated, modular architecture (figure 6) that can be easily adapted for each customer's purposes.

Figure 2. Azcal well pumps feed the same mainline pipe, leading to complex pressure management requirements.

The system integrator

"Not that many system integrators serve the agricultural market," says Williamson. "They are focused on post-harvest—pack houses—not really in the field."

As Williamson notes, agricultural customers are trying to solve fairly simple problems, but there are so many difficulties that it becomes complex. Assets are spread out over wide distances. You can't run ethernet wiring; the system has to be wireless. Cost is a huge factor as well, as farms don't usually have big budgets.

But the engineers at FDS have spent the last 20 years figuring out how to make technology in the field both relevant and cost-effective for growers. In the early years, they used their own technology for monitoring, but customers began asking for more features. So, FDS standardized on Opto 22 hardware and Ignition software from Inductive Automation, bringing agriculture into the internet of things (IoT). "Five years from now, I don't know how anyone will be able to farm efficiently without this IoT technology," says Williamson.

Figure 3. Azcal filter stations typically serve multiple crops in fields of various sizes.

Using the selected hardware and software, FDS has developed an end-to-end field monitoring and automation solution for crop irrigation management. Opto 22 *groov* EPIC controllers and *groov* RIO modules connect to sensors and equipment in the field to gather data and automate control (figure 4).

FDS's Water Informatics platform, an Ignition project hosted on FDS's private cloud, provides the control and data that farmers need in a way that they can understand and easily use. Each customer has a private view based on its login that shows just the assets and information for that ranch.

By avoiding expensive custom hardware that can be time-consuming to build and maintain, FDS can keep prices affordable while limiting downtime if something has to be replaced or upgraded. With off-the-shelf controllers, sensors that are already widely used in many other industries, and their own simple-to-use software, FDS's systems are affordable for farmers.

Not only has the company significantly improved irrigation management at more than 500 farms covering more than 50 crops (figure 3), but it also farms its own 200-acre technology lab to test system improvements.

The hardware

Farm Data Systems began using Opto 22 controllers and input/output (I/O) several years ago. They had used another company's products for pump control, but the systems were too expensive for most farms. When they discovered that these new IoT products could do the same things more efficiently, Williamson says, "Opto opened the door into Ag for us."

Initially, they chose the Ethernet-based, rack-mounted SNAP PAC R-series controllers and I/O for field installations. However, when Opto 22 released *groov* EPIC and *groov* RIO, they saw an opportunity to reduce costs further.

"There are 60,000 irrigation pumps in California, and 60 to 70 percent have only four to six I/Os," says Williamson. "It doesn't make sense to put a full controller in there." Instead, FDS uses a *groov* RIO universal I/O module, a small unit that offers a broad range of software-configurable signal types, plus built-in security and IoT communications.

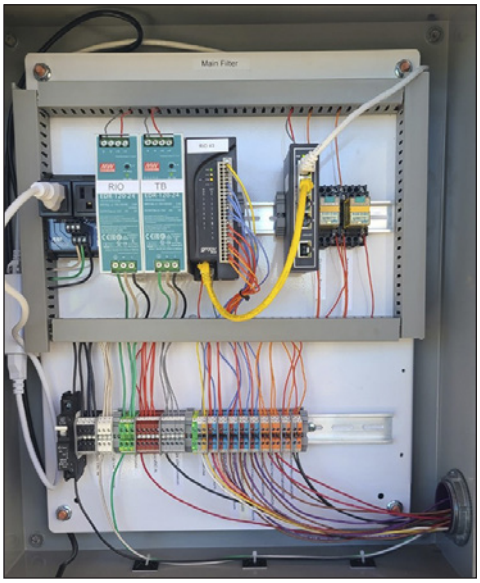


Figure 4. The controller with 10 universal I/O channels is well suited to Ag pumps.

For system control, FDS uses the *groov* EPIC edge programmable industrial controller. Designed for industrial automation and IoT, the controller offers security features, including a configurable device firewall, user accounts and authentication, data encryption, security certificate management, virtual private network (VPN) client, and dual independent ethernet ports.

Both *groov* EPIC and *groov* RIO include Node-RED and MQTT communications, which FDS is increasingly using to streamline data capture. A *groov* RIO at a remote location, for example, can send data via MQTT directly to an MQTT broker on the Ignition server.

The software

A key part of Farm Data Systems' installations is its project software, Water Informatics (figure 5). With a UDT library of all the features provided—pumps, flowmeters, moisture probes, every physical device—new assets can be copied and pasted to build out a new project in minutes. Once added, every feature can be expanded to other customers.

Because the architecture is hosted, FDS just needs to turn on customers' access to their individual pages. Adding a new client is "super-fast," notes Williamson. "The software part can be completed in a few days. Installing hardware is the bulk of the work."

Using industry-standard controller hardware and supervisory control and data acquisition (SCADA) software, FDS offers nearly 30 different modules hosted on a secure web server, from soil moisture monitoring to full irrigation automation. They constantly add new modules based on customers' needs.

For Azcal, FDS began by installing Opto 22 SNAP PAC I/O units at five well pumps. As soon as *groov* RIO was available, they installed *groov* RIO modules at an additional seven well pumps. The well pump I/O reports data on voltage transducers, virtual speed potentiometers, remote setpoints, current switches, VFDs, and flowmeters at each location and sends that data over Wi-Fi via an ethernet switch and a Ubiquiti bridge to the main tower location.

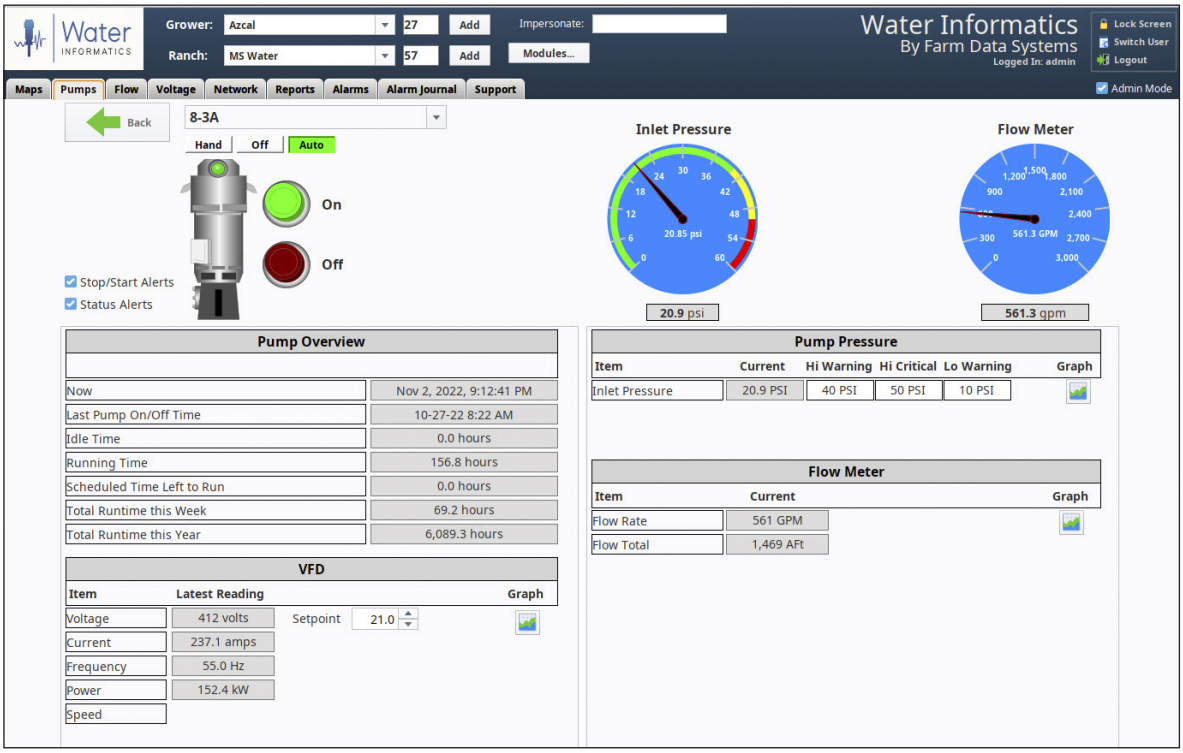


Figure 5. Farm Data Systems' software, Water Informatics, gives customers like Azcal data and control from PCs and mobile devices.

At the tower location a *groov* EPIC acts as the central controller, running an Opto 22 PAC Control strategy. From a dedicated network at the tower site, data is shared over a virtual private network (VPN) from the EPIC, through the internet. The customer data lives in the SCADA software on the Microsoft Azure cloud server.

The software gives Azcal the ability to access its system via mobile devices. From their phones or other devices with a web browser, Azcal can:

- Remotely start and stop pumps
- Control VFD frequency on four pumps using a virtual speed pot
- Control the pressure setpoint virtually on the remaining eight VFDs
- Continuously monitor pump pressure and flow rate
- Track VFD frequency, voltage, current, and power
- Monitor incoming line voltage and well health
- Receive alerts on critical operational issues and general pump activity
- Receive reports on pump activity and water usage

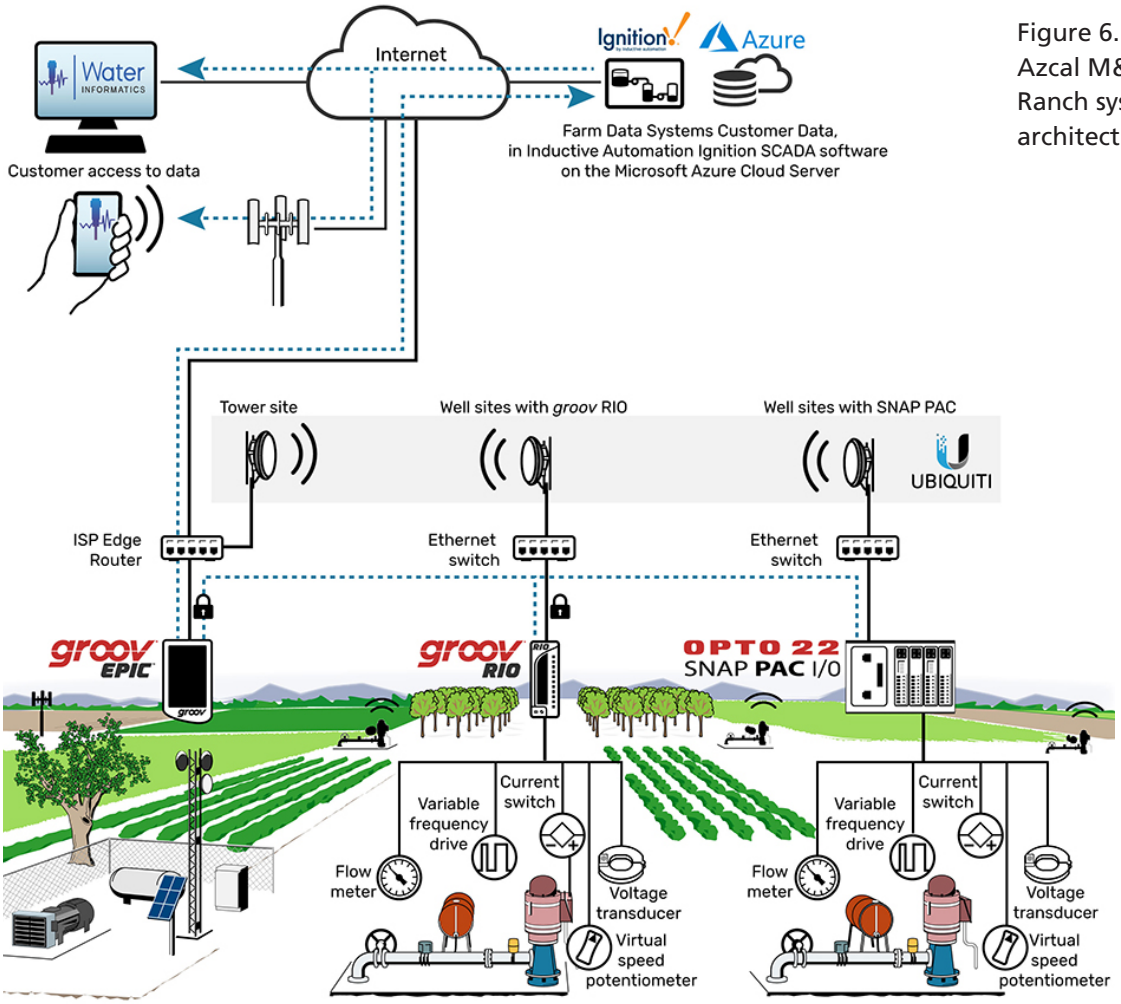


Figure 6. Azcal M&S Ranch system architecture.

The result

The manual monitoring and adjustments that used to take Azcal six or seven hours per day now take just a few minutes a day. "We are thrilled with the FDS solution. I am on top of pump management first thing in the morning before the day gets going. It just works!," says Sheely.

From day one, Sheely and Rhoads have been able to use the FDS client app for Water Informatics on their phones to power up any of their pumps within seconds. Additionally, they can see the pressures and flows continuously changing and make adjustments without having to jump into their truck to visit any of the sites directly. They also have visibility into their incoming voltage for the first time and receive text alerts any time the system loses power.

As Williamson notes, every part of the platform can be trusted to be secure and reliable.

Looking ahead

"The combination of Opto and Ignition is very flexible," Williamson says. "I can just keep adding features all day. We've already proposed to come back to add cascading PID control, so they don't have to do the remote control themselves. It will do it for them."

Each addition builds Farm Data Systems' ability to help existing and new customers. Says Williamson, "Every time we do something for them, we just add more features for all our customers."

Azcal has exactly the solution they needed at an affordable price. The latest industrial control technologies adapt well to an agricultural setting and start delivering return on investment immediately. As a result, Azcal is already rolling out the same technology across their other ranches, with additional features, including valve control and irrigation scheduling.

ABOUT THE AUTHOR

Benson Hougland is Vice President of Marketing and Product Strategy at Opto 22. With 30 years of experience in information technology and industrial automation, Hougland drives product strategy for Opto 22 automation and control systems that connect and secure the real world of OT with the systems and networks of IT and cloud. Hougland speaks at trade shows and conferences, including IBM Think, ARC Forum, and ISA. His 2014 TEDx Talk introduces non-technical people to the IoT.

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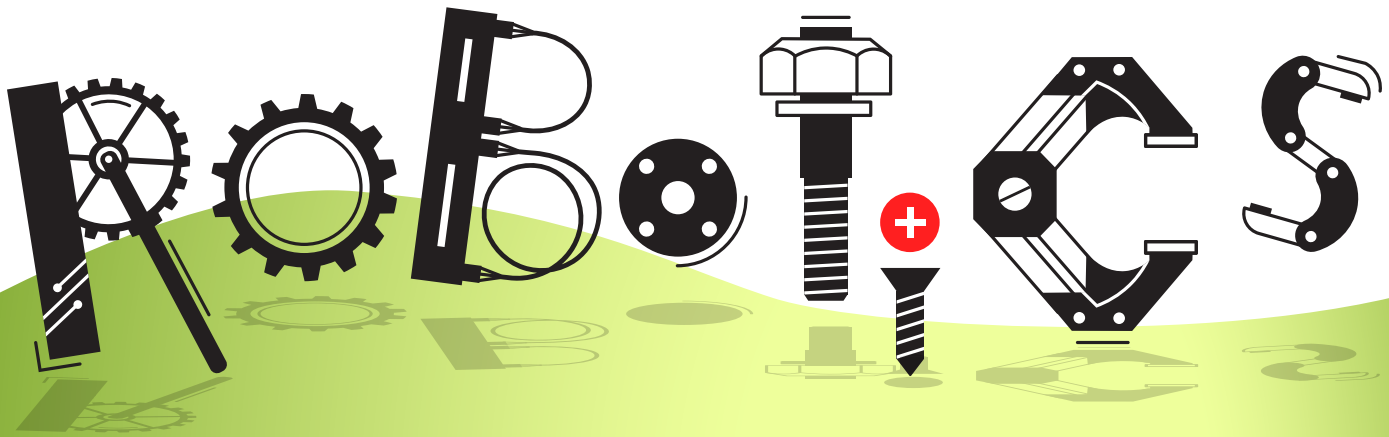
TSN IS CHANGING THE LANDSCAPE OF INDUSTRIAL ROBOTICS

Time-sensitive networking can help system integrators and end users enhance deterministic and reliable communications performance.

By Thomas Burke,
Mitsubishi Electric

The robotics industry is currently at more than $16 billion and is growing at a rate of more than 14 percent. Traditional applications involve replacing repetitive tasks. Robots are programmed for a single operation, or series of operations, at a work cell. Examples are assembly, painting, welding, etc. These are some of the easiest robotics applications to program and run.

As robots have proven themselves, we see them taking on more tasks that have typically been the domain of humans. These tasks are pick-and-place and assembly, often where source and destination positions are variable. Initially, robot applications were for high-value applications,



whereas the cost of a robot, integration, and configuration could be justified. These applications are often in electronics or product assembly.

We are seeing cost reduction in robots, their configuration, and long-term costs, and that is fueling applications in lower overhead markets like food sorting and packaging. As more robots are being applied in these profit-constrained markets, there will be continued pressure to reduce the overall costs of robot acquisition, installation, and maintenance. This will drive several significant trends: improvements in robot communications, configuration, and coordination.

Communications

Communications in the robotics industry must become more flexible and real time. Many robot applications today rely on preprogrammed movements with triggers to select them. This is the simplest case, where there are no communications at all. At the other extreme, we have the operation of several robots in confined areas with the need for coordinated movements and collision avoidance. For these applications, communications need to enable remotely controlled position commands and would benefit from the highest available performance. As with robot controls, there is also a spectrum of capability in industrial communications. As they become more remotely driven, coordinated by a combination of cameras and movement simulation, advanced industrial communication that leverages the leading edge will become a necessity.

Today, ethernet with time-sensitive networking (TSN) is the leading edge in industrial communications. TSN (figure 1) is an innovative ethernet technology defined by the IEEE 802.1 standard that resides at Layer 2 of the OSI 7-layer model. This is quickly proving its essential role in the connected industries of the future thanks to its unique ability to support convergence on the factory floor as well as between information technology (IT) and operational technology (OT) worlds. Its importance is being acknowledged by several sectors that are demanding automation solutions with TSN capabilities.

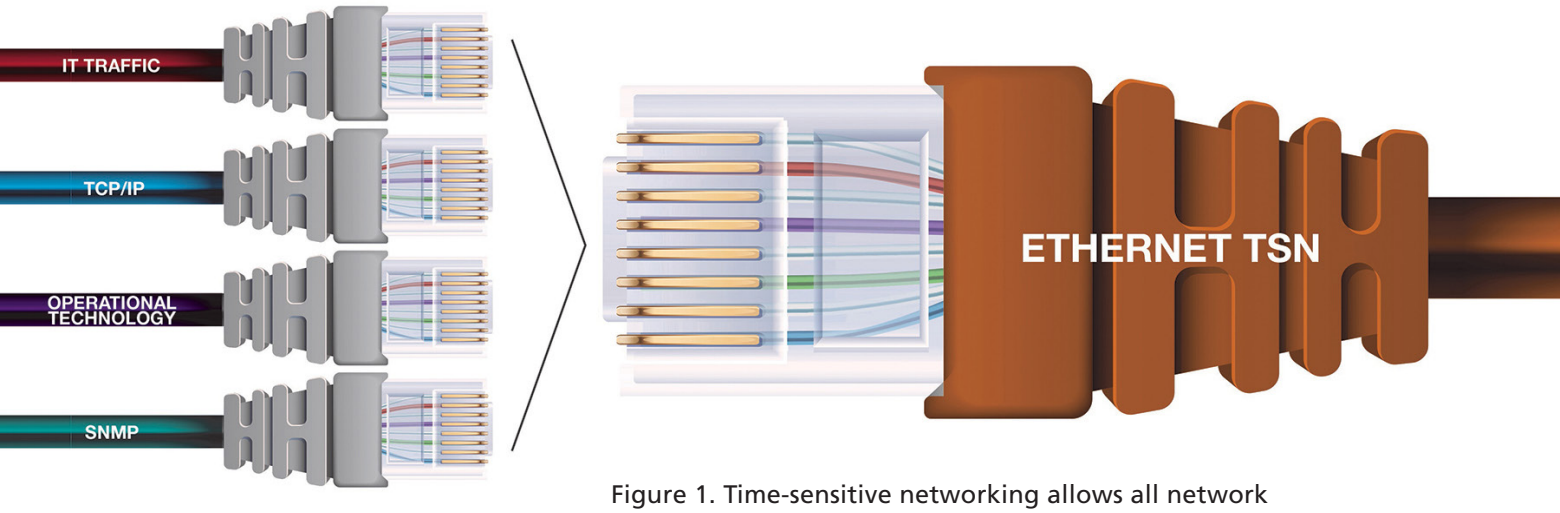


Figure 1. Time-sensitive networking allows all network communications to come through on a single cable.

Robot vendors might be wondering if the time is right to adopt TSN. In fact, there is a strong case for acting now. Implementing this technology within their products today is a safe bet that can enhance competitiveness and market share. Many businesses are currently in their digital transformation, and it is key for automation specialists to support them now with future-oriented solutions.

For those who think that maybe now is not the time for action, a clear parallel can be drawn between TSN and mobile phone technology, which has been quickly transitioning from 2G to 3G, 4G, and recently 5G. Instead of waiting for the next technology, competitive manufacturers promptly implemented these advances as the technology continued to evolve. This helped them address immediate market demands. Most technical specialists agree that any given technology continually evolves. Therefore, waiting for it to be "finished" is a futile strategy that will see their companies falling behind.

TSN role within industrial ethernet protocols

When adopting TSN, companies need to consider a number of practicalities. For example, forward-looking device vendors who are interested in adding TSN functions to their products might be wondering how TSN affects the general support that their solutions already offer for current industrial ethernet protocols. To this end, it's important to note that this innovative technology was designed to improve standard ethernet, and it only operates at Layer 2 of the OSI model. TSN is intended to work with various protocols and support their convergence to enhance interconnectivity, helping users have different traffic types coexisting on a single network.

Ultimately, this technology is just a "pipe," and therefore, industrial ethernet protocols are still required to cover the remaining application use cases, such as safety and motion control. It is important for robot manufacturers to understand that TSN cannot replace all industrial ethernet connectivity. Instead, they should leverage an industrial ethernet solution that supports all key uses cases while providing the convergence benefits offered by TSN, such as CC-Link IE TSN. This is the first open and widely supported network technology that combines gigabit bandwidth with TSN functions.

> Robot communications must enable remotely controlled position commands and would benefit from the highest available communications performance.

Upgrading robots and control devices

Once a key solution for industrial communications has been selected, companies should look at how to upgrade their products to provide these new capabilities. The development ecosystem available depends on the technology selected. For example, CC-Link IE TSN offers multiple op-

tions, both software- and hardware-based, that can offer different speeds of TSN implementation, device performance, and certification classes.

As a result of the many development methods available, vendors can ensure that the right technical solution is available for the specific product they want to deliver. For example, software protocol stacks are ideal for businesses that are interested in quickly implementing CC-Link IE TSN, as they offer perhaps the fastest method to enhance existing products by reducing in-house development time and costs. Furthermore, they are generally portable, so they can be applied with minimal changes. When performance is more important, hardware solutions are best suited to ensure CC-Link IE TSN conformance. These include application-specific integrated circuits (ASICs), also referred to as dedicated communication large-scale integrations (LSIs), as well as field programmable gate arrays (FPGAs).

Ultimately, TSN will change over time as all new technologies do, but automation vendors can benefit from considerable gains by providing innovative capabilities to their devices now. There is broad acceptance of CC-Link IE TSN today, and the ecosystem continues to grow rapidly. By leveraging this open network technology, both device vendors and machine builders can tap into new market opportunities quickly, futureproofing their businesses and their customers' operations.

Other benefits of TSN-based industrial networks

While we can certainly "engineer" ethernet reliability into an application by knowing what products will be using the network, and coordinating their use of that network, it requires closed, not open, networks. Closed networks can't help us with our need for continuous improvement, digital transformation, etc. The use of TSN-based ethernet communications means that we can reliably combine all communications, both IT and OT, on a common ethernet backbone.

TSN-based industrial network benefits include:

- **Access to all OT devices from your IT network.** This enables improvements in analytics, asset management, device management and configuration, and all things digital transformation.
- **Improved performance.** The combination of scheduling, prioritization, and greater bandwidth is resulting in the ability to handle larger and more complex applications reliably, especially in the motion control and robotics markets.
- **Simplified architectures.** These offer cost savings and improved reliability.
- **Easier troubleshooting.** Users can now leverage such IT tools as Simple Network Management Protocol (SNMP) to interact with and manage OT network devices, leading to a greater understanding of control elements and enhancing their dependability.
- **Reduced cost through new product delivery and market competition.** Initial solutions at the end of 2018 focused on high-performance applications around a limited set of vendors. But

over time, more device and infrastructure vendors have stepped forward with compatible product offerings and are now offering a robust ecosystem of solutions from which to choose.

Ethernet with TSN doesn't need to become your entire backbone for enterprise communications. It is more likely that system integrators and end users will implement "islands of TSN" that are dedicated to a machine or a production line, leveraging high-performance, deterministic, and reliable communications performance there, while bridging those communications to IT networks to enable wider access to information to achieve digital transformation.

There is a concern in the market. With more vendors leveraging ethernet with TSN, how can we ensure co-existence or interoperability? That question has recently been addressed with a new, cross-vendor initiative, the TSN Industrial Automation Conformance Collaboration. This collaboration between Avnu, CC-Link Partner Association, ODVA, OPC Foundation, and PROFIBUS & PROFINET International delivers a single common conformance test plan for the IEC/IEEE 60802 Profile of TSN for industrial automation.

Improved robot communications means more capability

As robot applications become more cost effective, they will be taking on roles that were typically done by humans. These will require greater complexity and the coordination of vision systems with robot coordination and collision avoidance. Robot manufacturers will need to work closely with a new class of companies focused on independent robot controls that will deliver camera vision-based solutions to drive robot movements, provide simulation solutions to manage those movements and avoid collisions, and quickly repurpose robots from one application to the next.

One leading robot provider is facilitating these needs for greater cross-company integration, not only with such leading communications as CC-Link IE TSN, but also with a partner program to drive collaboration and deliver integrated solutions to the robotics market. Called e-F@ctory Alliance, this program is offered by robot control vendors and system integrators that are able to deliver these new solutions.

ABOUT THE AUTHOR

Thomas J. Burke is the global director of industry standards for Mitsubishi Electric and leads the strategic development and adoption of networking standards, including Mitsubishi Electric's open networks solutions. Burke is also the director of strategic marketing for ICONICS and provides leadership to increase market share of its product portfolio.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Specifying Control Valves for Severe Service

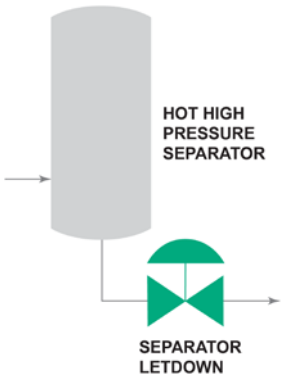
By Justin Goodwin, Emerson Automation Solutions

The best severe service application solutions can be found with research, process knowledge, and SME advice.

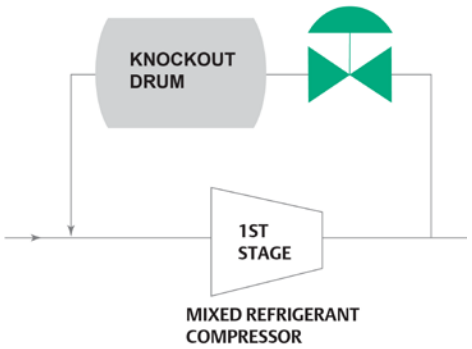
Severe service applications can be the bane of an automation engineer's existence because they often have higher than necessary maintenance and repair costs. The process or application is particularly punishing and almost always critical to plant operation, so getting it right is paramount. This article demystifies the severe service control valve selection process and provides advice to help end users make the right choice.

What severe service is

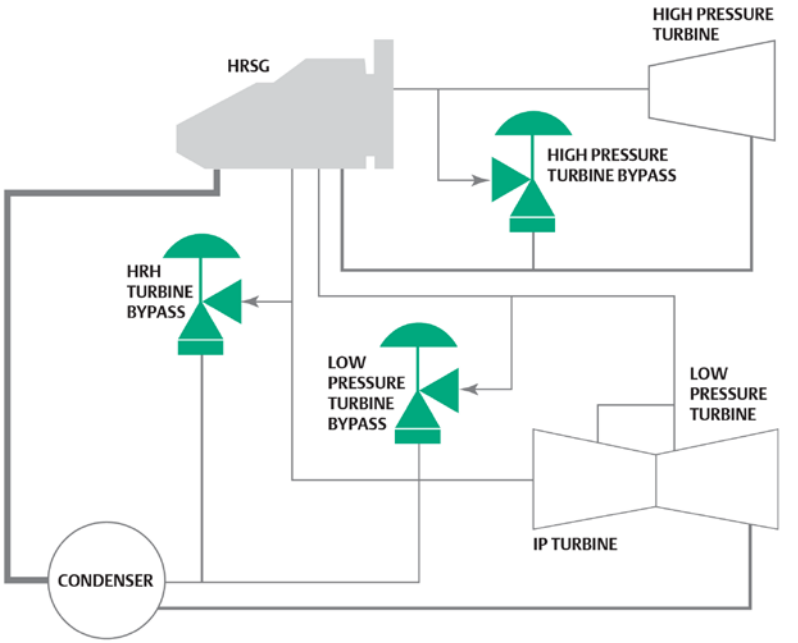
Severe service can mean different things to different people, but there are common themes to these types of applications. They usually involve high pressure drops that generate high noise and vibration in vapor service; flashing, cavitation, or outgassing in liquid service can occur as well. Temperature extremes, mixes of vapors, liquids, and solids, which tend to plug passages and erode internal components, and corrosion might also be encountered.



Refinery hot high-pressure separators



Compressor anti-surge valves



Turbine bypass valves

Figure 1. Three difficult control valve applications include refinery hot high-pressure separators (top left), compressor anti-surge valves (top right), and turbine bypass valves (right).

While this article discusses the severe service valve selection process in general, it focuses on three applications that most engineers would designate as severe service (figure 1). These include:

- Hot high-pressure separator (HHPS) letdown valves in a refinery
- Compressor anti-surge valves
- Turbine bypass valves

HHPS valves must endure very high pressure drops and high temperatures, and often involve a corrosive liquid entrained with solids, flashing, and outgassing through the valve. Anti-surge valves can go for months without opening, then suddenly be required to pass large flows at very high pressure drops with tight control. Turbine bypass valves usually face very high pressure drops, high steam flow rates, and large temperature swings.

Not one of these applications is easy, but each has solutions that can minimize maintenance, repair, and operational costs by following a step-by-step methodology.

Step 1: Evaluate the process

The severe service selection process starts with a solid understanding of the application, and many poor control valve choices can be attributed to a failure to perform this critical step. Often, the user has the normal process conditions well defined, with a solid understanding of the inlet and exit pressures, process temperatures, and process media characteristics.

However, users often get tripped up by the unexpected process conditions. What happens during upset conditions or when the plant is starting up? Must the valve handle markedly different flows or pressure drops at this time? Will temperatures range higher or lower than expected?

Changes in the process fluid itself are another major source of problems. During abnormal situations, the valve may need to pass impurities, or it may be prone to flashing or more outgassing than normal. Any of these situations could destroy a valve quickly if it is not designed appropriately.

Step 2: Understand the valve challenges

With a sound knowledge of the range of process conditions the valve will face, the user now needs to evaluate what impacts those conditions have on the valve. Following is a partial list of potential valve challenges:

- High pressure drop, vapor service: The valve is subjected to very high velocities, high noise levels, and high vibration. Sound levels of more than 110 to 115 dB will damage the valve.
- High pressure drop, liquid service: In this case, the liquid tends to flash, cavitate, or outgas. Eventual valve damage may be unavoidable in some cases, but better designs can dramatically extend the service life.
- Cryogenic temperatures: These temperatures can both embrittle metals and make valve sealing difficult, so special materials for construction and body designs are necessary.
- Very high temperatures: High temperatures require specialized alloys to maintain strength, while thermal expansion and thermal gradients can cause valve components to bind and stick. Packing designs also must be carefully tailored to suit the application.
- Two-phase flow: Liquid/vapor combinations subject the valve to cavitation and choked flow.
- Solids/particulates: Entrained particles in either liquid or vapor commonly cause issues such as erosion and plugging.

- Corrosion: Corrosion comes in many forms, and each must be handled differently. Identifying the method of attack can be difficult because there are often multiple types of corrosion occurring simultaneously.

Most severe service applications involve some combination of these challenges, and all must be accounted for during valve selection.

Step 3: Consider solution options

Once a user is armed with a complete understanding of both normal and abnormal process conditions and has identified the challenges those conditions pose to the valve, the correct valve can be chosen. The user is typically faced with a dizzying array of options, but only a few of them will perform well in their specific application.

So how to choose? Some vendors offer customized solutions, which may well provide superior performance, but one should evaluate those options carefully. Users should look for a valve partner with an established track record of proven designs, and a history of supporting its products after the sale with engineering support and local service.

A starting point is evaluating the body design itself. It should be appropriate for the application, and some body styles have distinct advantages. For example, angle valves (figure 2) are often the best choice for two-phase liquid cavitating/outgassing service because this design can minimize damage to the seat and valve body as the liquid/vapor combination exits the valve. Angle valves also are commonly used in turbine bypass applications because the design allows compact incorporation of desuperheating water sprays for efficient steam temperature control.

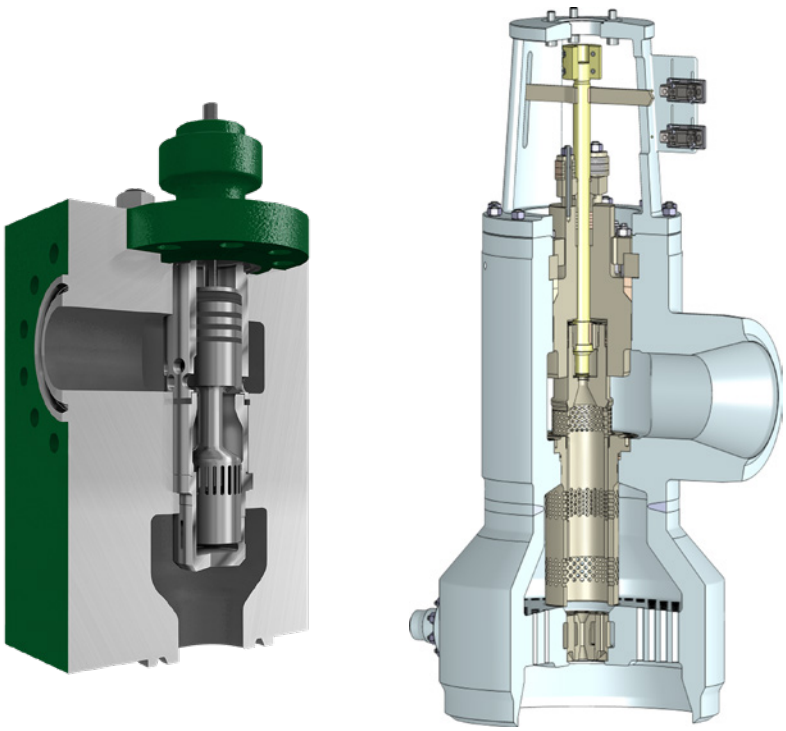


Figure 2. Angle-body style valves have inherent advantages for some severe service applications. The dirty service trim valve (left) handles outgassing liquids with entrained solids common in HHPS applications. The turbine bypass valve (right) has an integrated desuperheater to control steam temperatures.

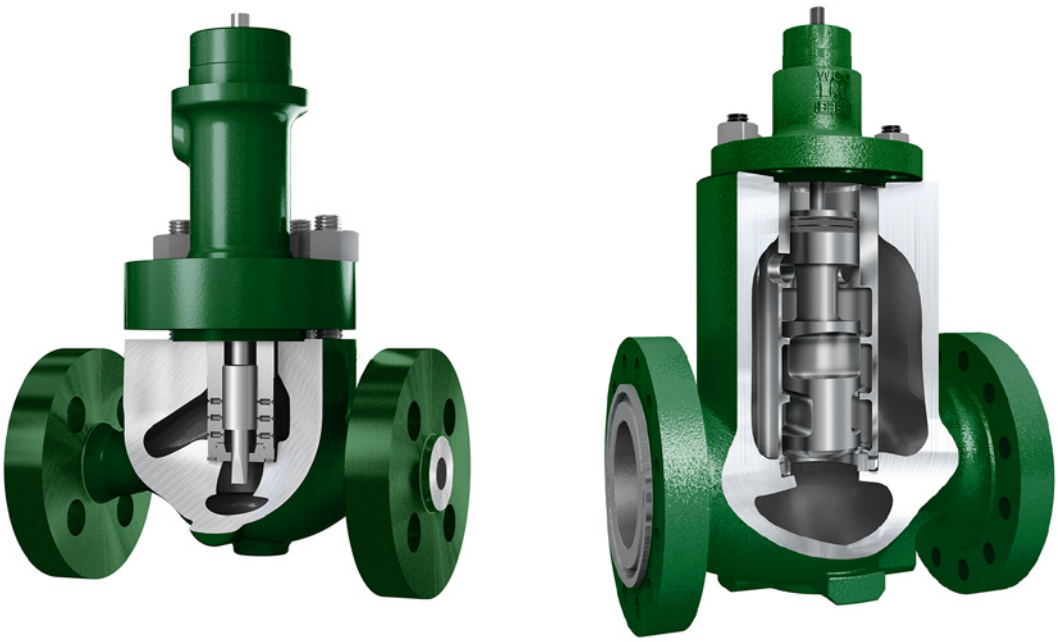


Figure 3. Anti-cavitation trims are also available in globe valves, as well as angle valves. Simpler designs (the trim on the left) use small holes to absorb multiple pressure drops and direct cavitation away from the seat and body. More complex designs (right) have larger openings to handle entrained solids.

In some cases, the piping configuration does not easily accommodate angle-style valves, so globe-body styles are a better option. Fortunately, there are anti-cavitation trim designs (figure 3) suited for these applications as well.

Valves in high-pressure-drop vapor applications, such as compressor anti-surge valves, are designed to handle high-velocity vapor flows, while reducing the noise and vibration that would otherwise result. Low-noise trims (figure 4) incorporate slots or holes to separate the flow into smaller parallel paths, and they may also use a series of pressure stages to manage pressure drops and reduce sound power level.

Figure 4. Low-noise trims vary from single-stage trim (left) to multipath (middle) to multipath and multistage (right). Higher pressure drops and vapor velocities typically require these types of complex trim designs.

Figure 5. Additive manufacturing has made a whole new generation of innovative designs possible. Additively manufactured noise trim (left) controls valve noise with increased flow capacity, and the anti-cavitation trim (right) allows rotary valves to be installed and perform well in cavitating applications.

Low-noise trims reduce noise and shift noise frequency into ranges that are less detectable to the human ear. As valve pressure drops increase, low-noise trim designs tend to get more complex because multiple stages are required to achieve the required noise reduction.

Anti-surge valves pair low noise trims with specialized high-capacity, intelligent digital valve positioners to achieve the extremely fast response required by this application. These valves also can incorporate engineered deadband to allow partial stroke testing without passing significant flow, as well as diagnostic capabilities in the digital positioner to ensure reliability.

Additive manufacturing, in this case 3-D metal printing, has made a host of new designs possible that were either not economical or feasible to manufacture using conventional techniques (figure 5). These types of designs can incorporate high-strength alloys in novel configurations to create new solutions for a variety of applications.

Step 4: Use suitable materials

Material selection is critical for success in severe service applications. Trim and body components often are subjected to damage from cavitation, flashing, and erosion. Packing materials are subjected to high temperatures and pressures, and all wetted parts are subjected to corrosive attack. A severe service valve incorporates a variety of materials for different components to best address the conditions each is expected to encounter.

Fortunately, additive manufacturing has improved this area of valve design as well. These manufacturing techniques allow very high-strength alloys to be used where they could not be employed before, resulting in longer service life and reduced maintenance.

Step 5: Seek advice

It should be clear from this article that the number of valve component options can be overwhelming. When faced with evaluating the best solution, it is advisable that the user seek help and advice. Corporate engineering may have some suggestions, as may sister plants that encounter similar applications. Peer recommendations from end users at other companies can be helpful, and these types of discussions are common at International Society of Automation (ISA) meetings. It also may be wise to engage your control valve partner, who will typically have a good understanding of the myriad alternatives and can help users make informed decisions.

Severe service applications are not insurmountable problems, but considerable effort is required to thoroughly research them before the best solution can be found. Taking the time to fully understand the details and to seek guidance from knowledgeable peers and partners can go a long way to ensuring a wise and successful decision.

All figures courtesy of Emerson.

ABOUT THE AUTHOR

Justin Goodwin is the director of the steam conditioning group at Emerson. He has a BS in mechanical engineering from Iowa State University and a BA in applied math from Grand View University. Goodwin has been responsible for the design and technical support of steam conditioning and desuperheating equipment since 2005. Today, he provides direction, technical oversight, and training for Emerson's global steam conditioning business.

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IPC Cuts Temperature Measurement System Component Count

By Jesse Hill, Beckhoff Automation LLC

Bonnenberg & Drescher leverages flexible, fully integrated automation and measurement technology.

Highly complex plants in energy, steel, and other industries place high standards on measurement and analysis technologies. These demands include not only fast and precise data acquisition, but also a system design that is as flexible, expandable, cost-effective, and space-saving as possible. This is why Bonnenberg & Drescher GmbH relies on PC-based automation and measurement technology from Beckhoff for its acoustic gas temperature measurement (AGAM) system (figure 1).

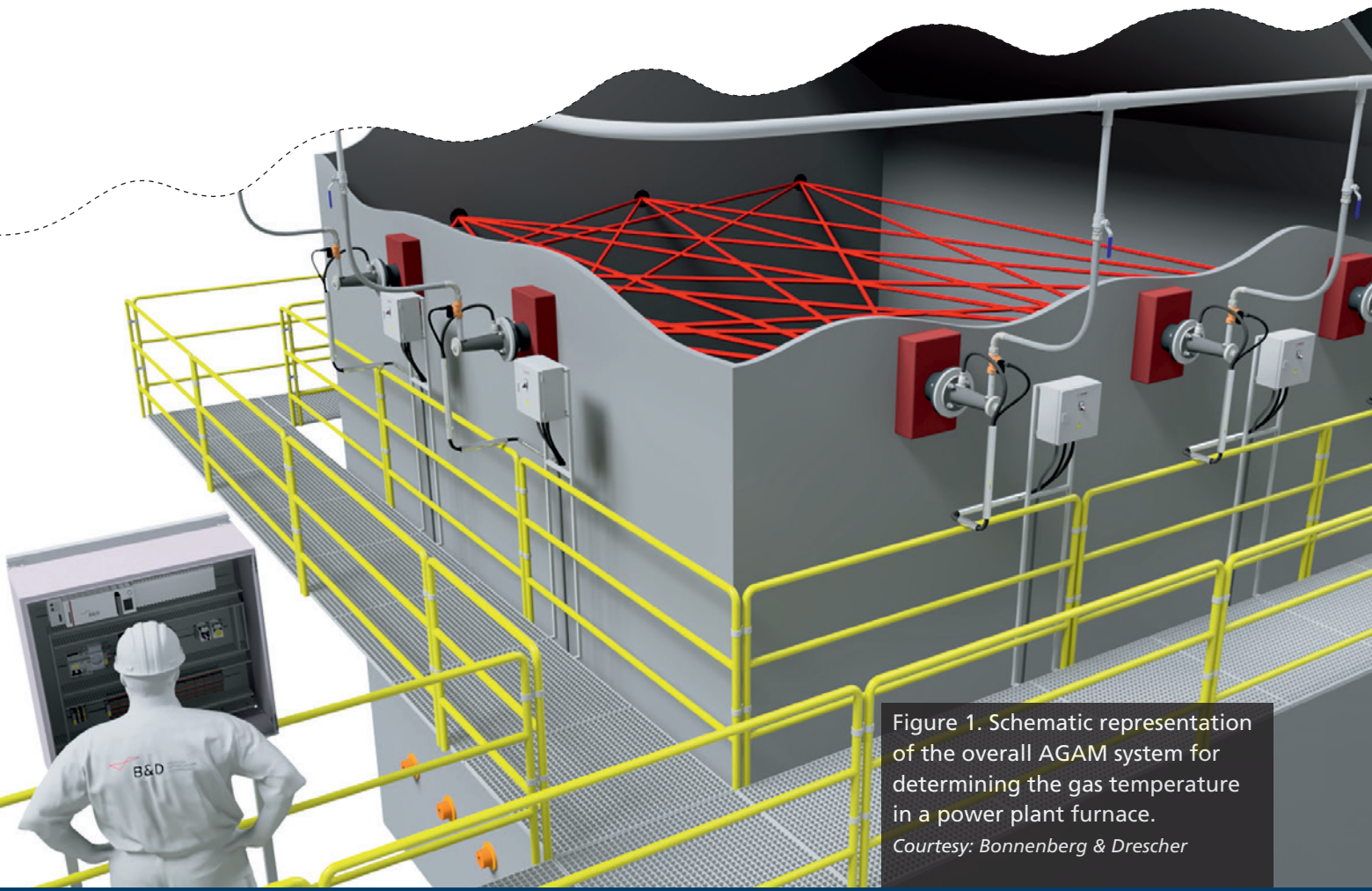


Figure 1. Schematic representation of the overall AGAM system for determining the gas temperature in a power plant furnace. *Courtesy: Bonnenberg & Drescher*

Figure 2. In front of an AGAM system: Dr. Matthias Ritter (left) and Dr. Martin Brodeck (right), both managing directors of Bonnenberg & Drescher, and Ralf Stachelhaus (center), head of the Beckhoff Rhine-Ruhr, Germany branch office.
Courtesy: Beckhoff

A fully integrated system delivers advantages

"The integration of measurement data acquisition, archiving, analysis, and presentation offers tangible benefits for us," says Dr. Martin Brodeck, managing director at Bonnenberg & Drescher (figure 2). "At the start of the measurement chain, special electronics are replaced by standard fieldbus technology. This guarantees the supply of spare parts for decades and ensures that we are continuously involved in innovations without having to dedicate resources ourselves."

Another important aspect that Brodeck mentioned is the long-term availability of the CX2062 Embedded PC. Like all PC-based machine controllers from Beckhoff, it is available for at least 10 years and subsequently covered by service for a further 10 years—and on a worldwide basis from 40 Beckhoff international subsidiaries as well as partners in more than 75 countries. "Our customers can obtain these components almost anywhere in the world," Brodeck says.

"The handling of the entire system has been significantly simplified, so it has become much more manageable for our customers. In many cases, they can now help themselves without us having to intervene," Brodeck says. "What's more, having the embedded PC as the basis of our platform ensures a successful symbiosis of automation technology and the IT [information technology] world, which is an invaluable advantage, especially for our computationally intensive applications including database connections and web interfaces."

Based in Aldenhoven, Germany, Bonnenberg & Drescher specializes in process analysis and optimization and works primarily in combustion applications. The company was founded in 1971 and initially dealt with nuclear engineering projects, from the design and lifetime analysis of cooling systems and critical components to nuclear safety considerations such as radiation protection, radioactive emissions, and their behavior in the environment. In the 1980s, its range of services expanded to include conventional power plants, with a particular focus on the analysis and optimization of combustion processes. The company has used the AGAM system for this purpose—as well as in waste incineration and blast furnaces—since the early 1990s.

What Bonnenberg & Drescher went through to get there

The physical principle behind AGAM is simple: The speed of sound in a gas depends on the gas temperature—the hotter the gas, the faster the propagation speed of the sound waves. For accurate measurement of gas temperatures, several microphones are distributed around the boiler, which in turn generate a signal that is received simultaneously by all units. This is then used to calculate a 2-D temperature profile of the gas in the boiler. An advantage of this method is the radiation-free measurement of the gas temperature, which is used to optimize processes within the plant for results including:

- Optimized combustion to reduce fuel usage and lower CO2 emissions
- Significant reduction of corrosion in the plant
- Increased plant throughput and availability (waste incineration)

The physical principle behind AGAM is simple: The speed of sound in a gas depends on the gas temperature—the hotter the gas, the faster the propagation speed of the sound waves.

PC-based control replaces specialized products

In the past, the system setup for this measurement and analysis system was implemented rather conventionally. Up to 16 channels with a 25-kHz clock frequency (i.e., 400,000 values per second) were acquired and processed using a powerful server system for measured value processing and archiving (through methods such as Fourier transformation and correlation). The previous setup also required a programmable logic controller (PLC) for simple automation functions and various special products such as analog-to-digital (A/D) converters for fast, deterministic and high-resolution acquisition of analog signals (sound waves).

In the updated system (figure 3), PC-based control technology from Beckhoff reduced the number of necessary components to a single machine controller. The CX2062 Embedded PC (figure 4) offers capable performance for the computationally intensive analyses. The many-core CX2062 offers an eight-core Intel Xeon processor (2.0 GHz clock frequency), and even more powerful processors are available if necessary.

According to Bonnenberg & Drescher, the fast and time-synchronous acquisition and digitization of the analog signals is particularly important for analysis system quality. The higher the sampling rate, the more accurate the temporal resolution. Also, the lower the jitter, the more accurate the temperature measurement via Fourier analysis and correlation of the measurement

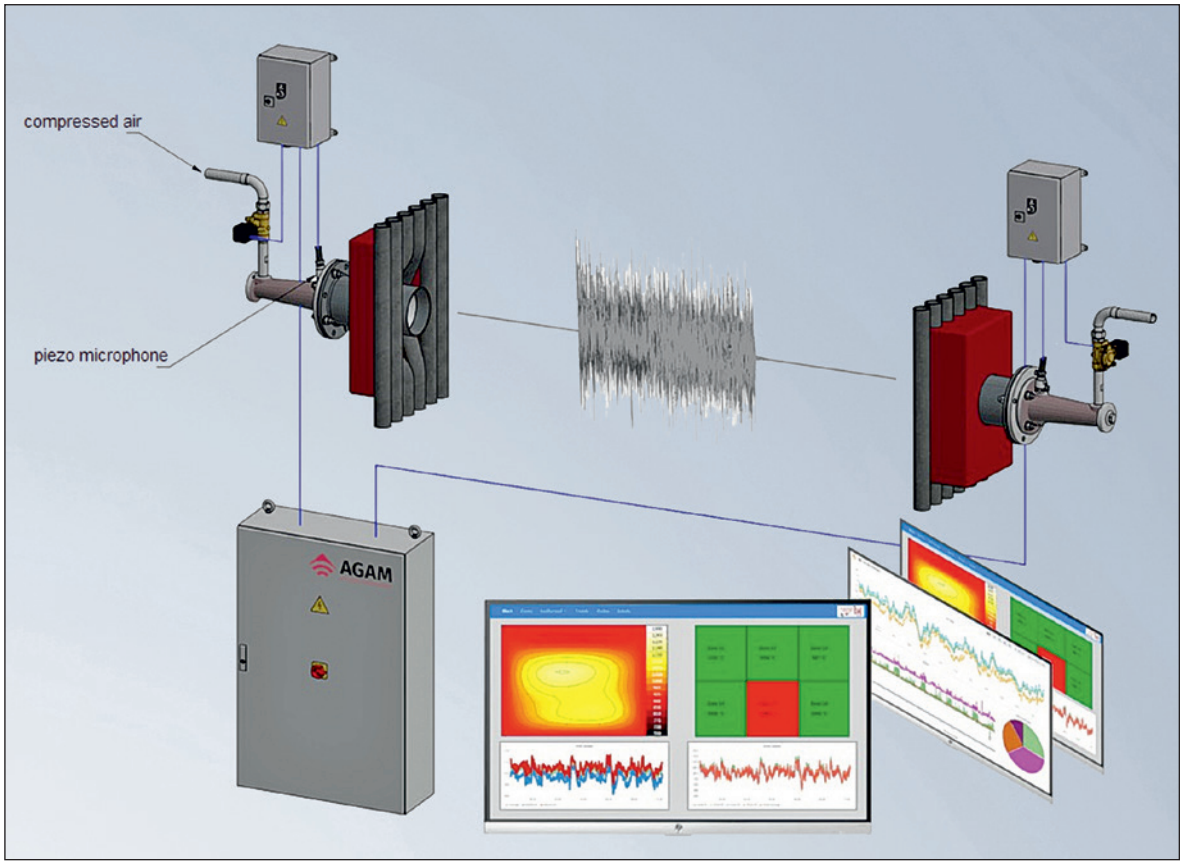


Figure 3. Measurement setup for acoustic gas temperature measurement (AGAM) by Bonnenberg & Drescher.
Courtesy: Bonnenberg & Drescher

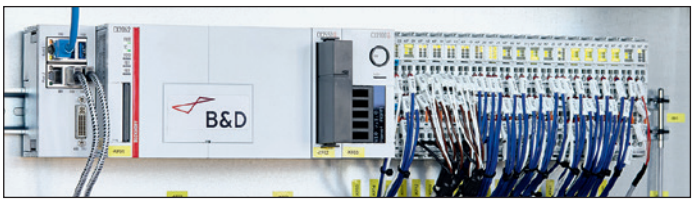


Figure 4. The CX2062 Embedded PC with the attached EtherCAT Terminals forms a powerful and compact control solution for the measurement and analysis system.
Courtesy: Beckhoff

channels. For this, the EL3702 EtherCAT analog input terminals provide oversampling functionality. This means the terminals run their own measurement cycle in addition to each fieldbus cycle, which they can use to get even more granular data. The distributed clocks of EtherCAT mean the time resolution is also very precise at ±20 nanoseconds. What's more, the entire data set is synchronized and time-stamped with the EtherCAT cycle and the TwinCAT software application with the same accuracy. With the EL3702 EtherCAT Terminal, signals can be acquired at up to 100 kHz, and the number of channels is no longer limited to 16 with the new system.

Modular system increases flexibility

The communication center of a TwinCAT system is the ADS router. From here, the pre-processed data is available to other applications. The data transfers to the C# environment of the AGAM system for further processing via ADS-DLL. The results then transfer back to the TwinCAT system via ADS and can be forwarded from there to customer systems via common fieldbus interfaces, such as EtherCAT, PROFINET, and Modbus, or made available as a visualization web interface in the customer's network.

On the input/output (I/O) level, the system is also very easy to expand in Bonnenberg & Drescher's experience. Existing systems can expand by plugging in additional terminals, and only further instances of existing software modules have to be formed within the software. The availability of EtherCAT couplers with fiber-optic interfaces (plastic, multi-mode, or single-mode fiber optic) makes the system even more flexible, as this makes it possible to reach distant measuring points and minimize analog wiring.

Quality assurance through reciprocal control system

The use of Beckhoff technology has also resulted in significant progress in terms of quality assurance. The necessary simulations use essentially the same system in the measurement technology, just on a reciprocal basis. The components on the boiler are simulated by generating the microphone data via the EL4732 oversampling analog output terminals, and the 24 V signals correspondingly in the reverse direction. Each measurement system undergoes several days of endurance testing before it is delivered to customers.

The modified AGAM-Q1 system also has been available since 2021. It has been approved by German inspection body TÜV and is suitable for use in official and certified temperature measurement in plants. The EL4723 output terminals are used for the legally required self-test of the measurement system.

Overcurrent protection terminals save space and costs

In the case of the EL9227-5500 electronic overcurrent protection terminal, the initial focus was on its standard use: replacing conventional fuses with an electronic fuse with an EtherCAT interface.

The benefits of this include:

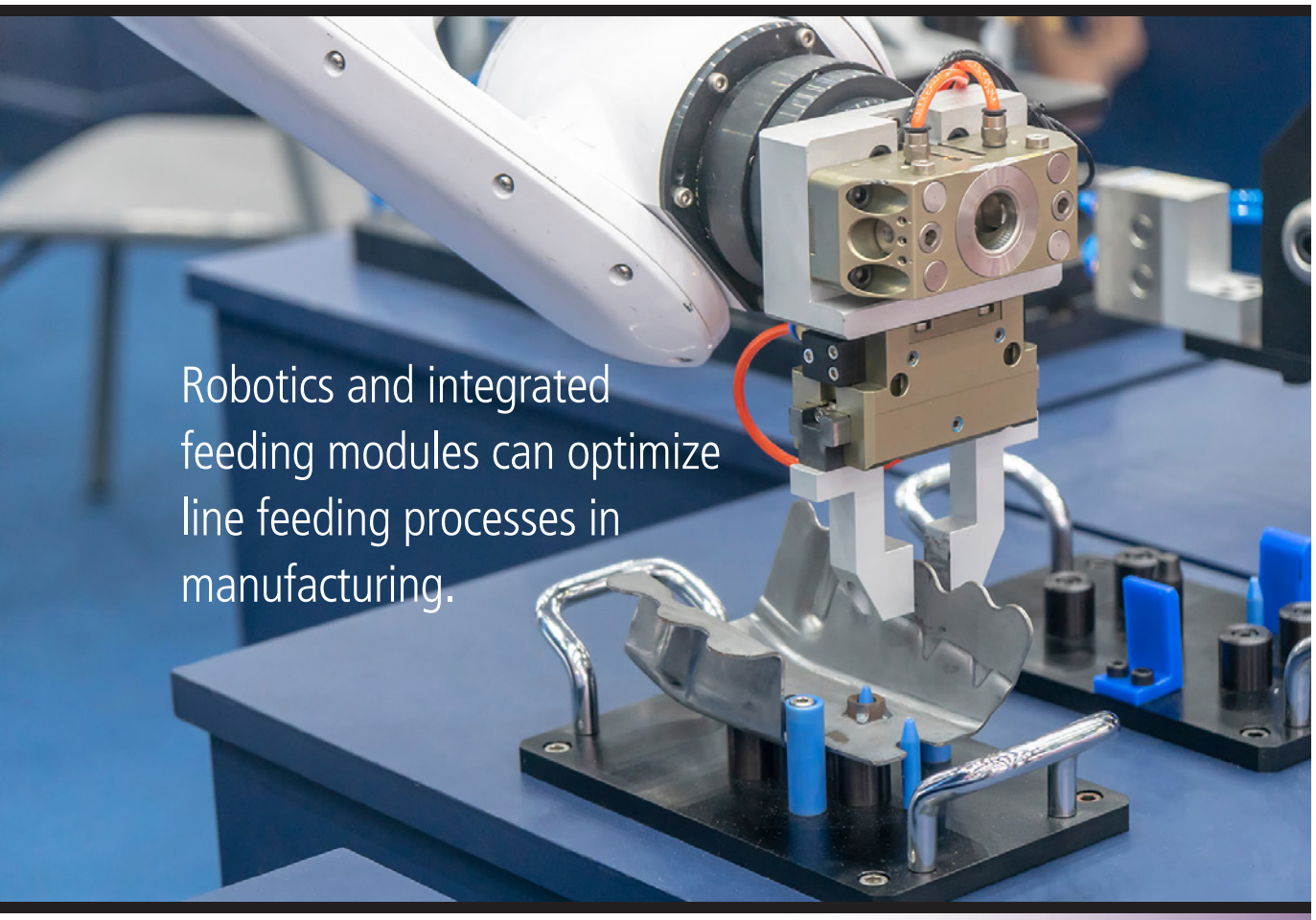
- Space and cost savings
- Flexible configuration of tripping current, warning levels for current and voltage, fuse characteristics, starting behavior, etc.
- Complete measurement function of current and voltage as cyclic process data for the PLC (power supply and load diagnostics)
- Extensive diagnostics, for example, with regard to trigger reason, setting changes by users and log files

In addition, Bonnenberg & Drescher also identified another very useful application scenario. The electronic overcurrent protection terminal serves as a digital switching output with measurement and diagnostic functions, namely for solenoid valves. The measurement functions of this EtherCAT Terminal enable the current and voltage characteristics at the switching point to be displayed as trend lines for easy and reliable diagnosis of various valve faults such as cable break, coil defect, or mechanical defects in the valve.

ABOUT THE AUTHOR

Jesse Hill is process industry manager at Beckhoff Automation LLC.

Flexible Feeding for a Smart Production Line



By Nigel Smith, TM Robotics

As an increasing number of industries embrace automation, vibratory feeders are becoming more widely used. They offer a quicker and more effective alternative to manual feeding but can be inflexible and complex to incorporate into existing systems. To improve on this, EPF Automation developed the Supata, an integrated flexible feeding module. The system comes equipped with a Shibaura Machine, formerly Toshiba Machine Robot, available through TM Robotics.

Vibratory feeders are used to align and feed small products and parts during the assembly and production process using gravity and vibrations. They are a common element of many operations and an effective way of automating production lines. However, they are notorious for being unreliable and rigid, and they lack the flexibility needed for an agile and adaptable production line.

To address the limitations found in standalone vibratory feeders, EPF Automation engineering has developed the Supata system. This is a fully realized robotic solution suitable for use in any industrial production setting. Its features make it good for manufacturing and production in the automotive, technical, medical, and electronics industries, where precision and speed are important.

The equipment

The Supata system (figure 1) consists of feeding, vision, and robotic handling systems, and a control system/human-machine interface (HMI). It has been designed for manipulating and singularizing products and components for quick and precise assembly. Its vibratory smart feeder system consists of a vibrating table and a hopper, allowing it to handle components of various sizes, shapes, and materials that range from less than 10 mm to more than 250 mm in size and 25 g to 350 g in weight. This gives it versatility when integrating the system into new or existing production lines.

The machine's vision system uses artificial intelligence (AI) for accurate recognition and high precision. With this technology, algorithms can identify and locate components on the vibratory plane using a camera and pass coordinates on to the robot for picking.

Figure 1. The Supata system consists of feeding, vision, and robotic handling systems, and a control system/human-machine interface (HMI).

The software is straightforward for reconfiguring production changes and has integrated quality control for whatever components are handled, making it adaptable to operator requirements. The AI also can reduce the number errors, increasing productivity by 17 percent to 20 percent.

The system

The system comes equipped with a Shibaura Machine robot as its handling system. Users can customize this by choosing six-axis, SCARA, or collaborative robots depending on their requirements. Both SCARA and six-axis robots are good for pick-and-place applications due to their large range of movement and high precision, and in the Supata, the robot can place components wherever required by the operator. SCARA robots can work at high speeds on four axes and are suited to small-scale applications that require accuracy and precision. Six-axis robots have superior directional control thanks to their articulation and movement on two additional axes and are capable of advanced movement profiles and intricate processes. Operators have control over which robot best suits their specific needs.

The control and monitoring system (CMS) is an integral part of the Supata system. Run using edge-computing technology, the machine has been developed for Industry 4.0. The CMS also allows remote connection so operators can monitor machine function from any location for access and analysis.

SCARA robots can work at high speeds on four axes and are suited to small-scale applications that require accuracy and precision.

Integration characteristics

In terms of physical integration, the system can be configured to fit into existing workshops and production lines with ease. The chassis is tough and durable to withstand long-term use in an industrial environment and minimize the risk of damage. Moreover, it is available in different designs and sizes. Buyers can choose a fixed structure, or a versatile mobile chassis with various docking stations to meet different needs.

A key advantage of a fully integrated solution is the ability to maintain a constant cycle time, with the potential to reach one part per second. The configurable system also can handle a large range of materials and geometries and operates from a single interface, making it simple and user-friendly.

Supata is a fully engineered system. Many other suppliers can provide single components, but this is much more complex to incorporate into existing assembly lines. By supplying a modular station that contains a complete solution, it is more straightforward to integrate into new and existing lines.

Final thoughts

Modern manufacturing can be fluid, with frequent changes to products or formulations, and equipment should be as agile as possible to facilitate this. Supata can be used to produce small batches with frequent changes and is fully configurable depending on application. The straightforward, plug-and-play system is always ready to manage new products of different types from a single interface, and its AI algorithms can reduce costly errors and improve turnover significantly.

For operations requiring vibratory feeding, equipment that's able to keep up with the demands of Industry 4.0 is more important than ever. Choosing an integrated and innovative solution can not only improve productivity and cut costs, but also help to create an agile and futureproof line.

ABOUT THE AUTHOR

Nigel Smith is CEO at TM Robotics. He directs the overall growth and development of TM Robotics throughout Europe, the Middle East, Africa, Russia, and North and South America. Smith founded TM Robotics after holding several positions at Toshiba International, where he was responsible for sales, marketing, and support of its programmable logic controller (PLC) and industrial robot product range throughout EMEA. Smith's close relationship with Toshiba Machine has enabled him to influence product updates and the creation of new robots, including end-of-arm tooling, robot mechanical structures, and new controllers for the European market.