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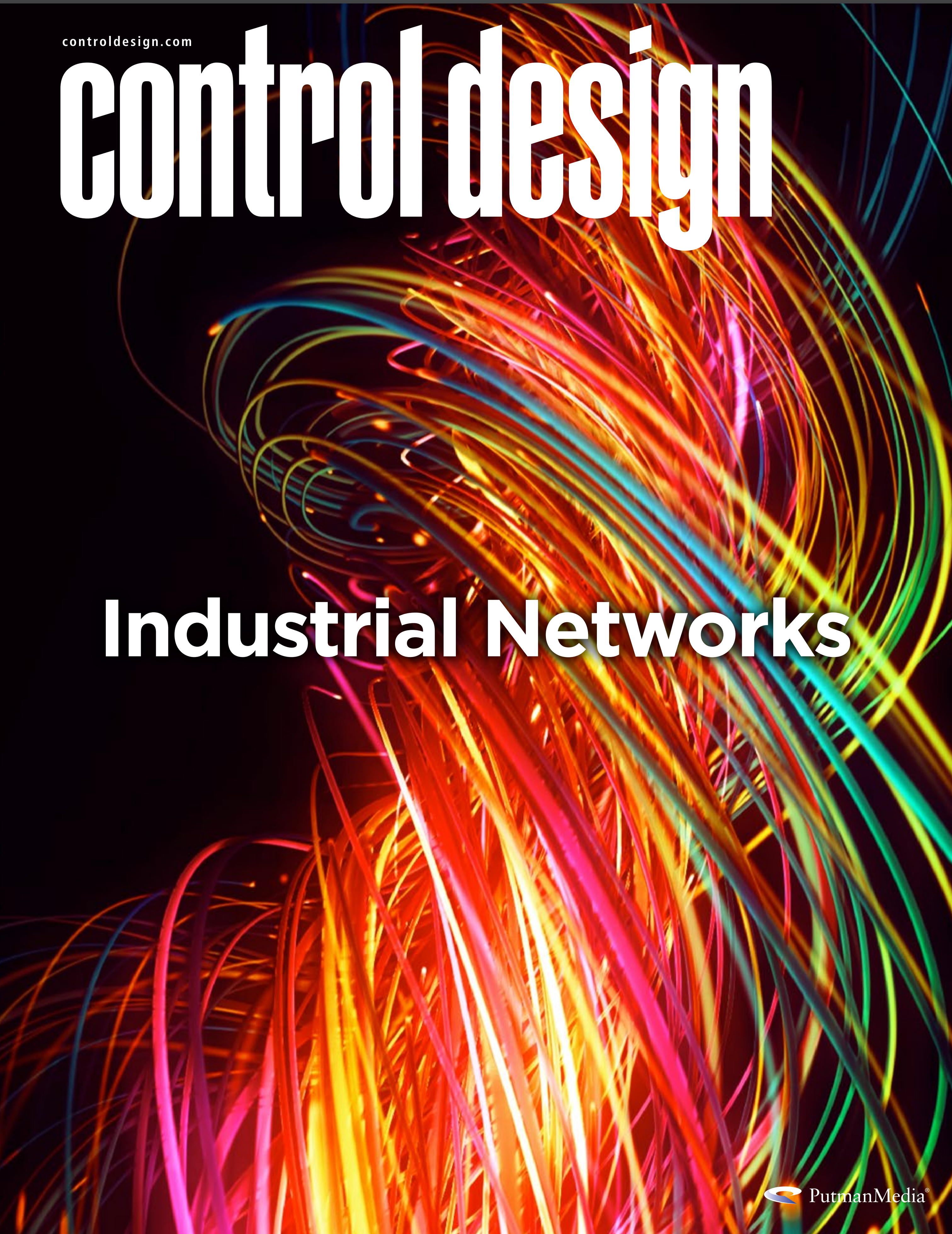

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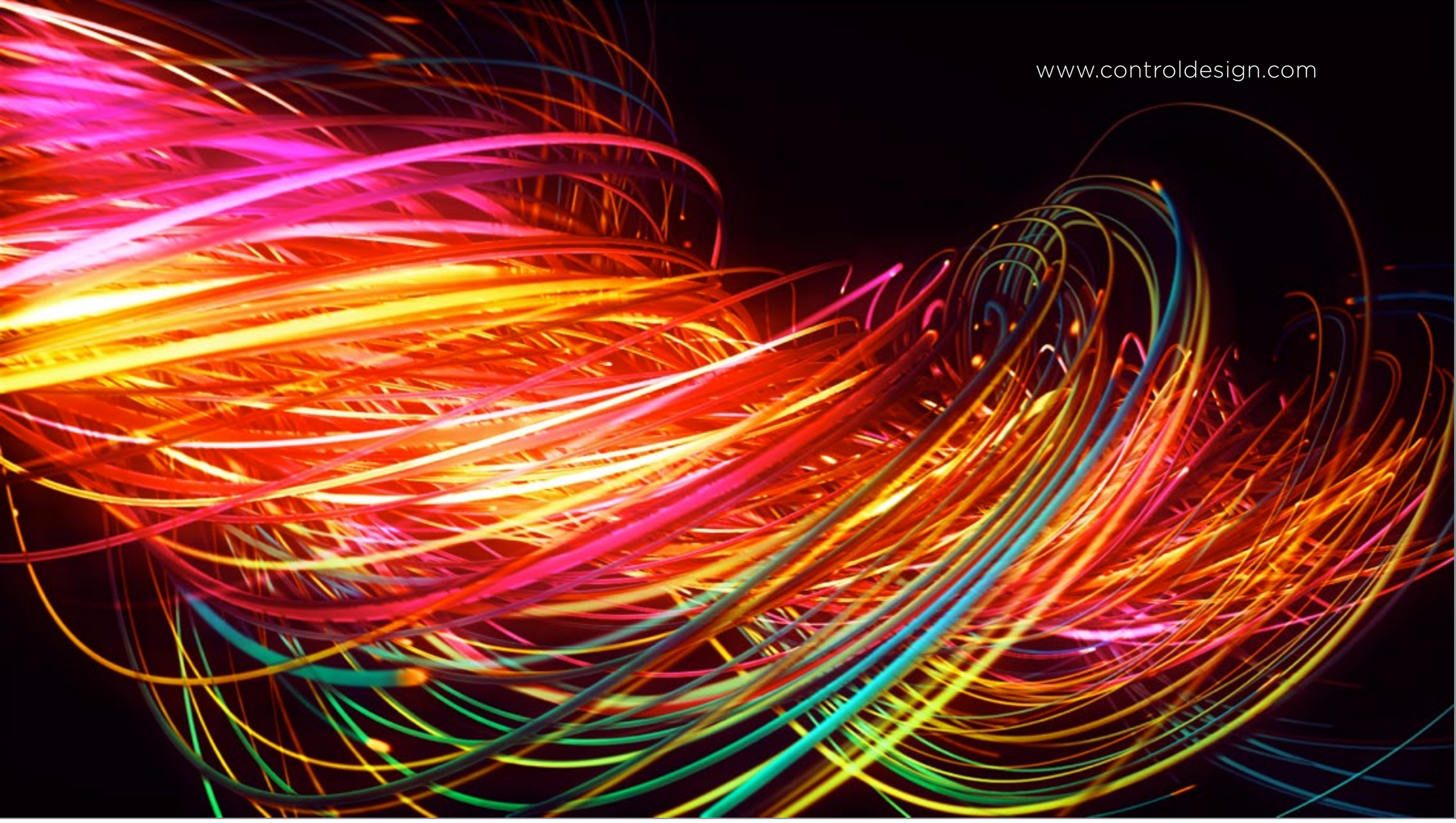


TABLE OF CONTENTS

Remote monitoring aids in PdM practices 4

How to harness the best of IT to solve problems in OT 10

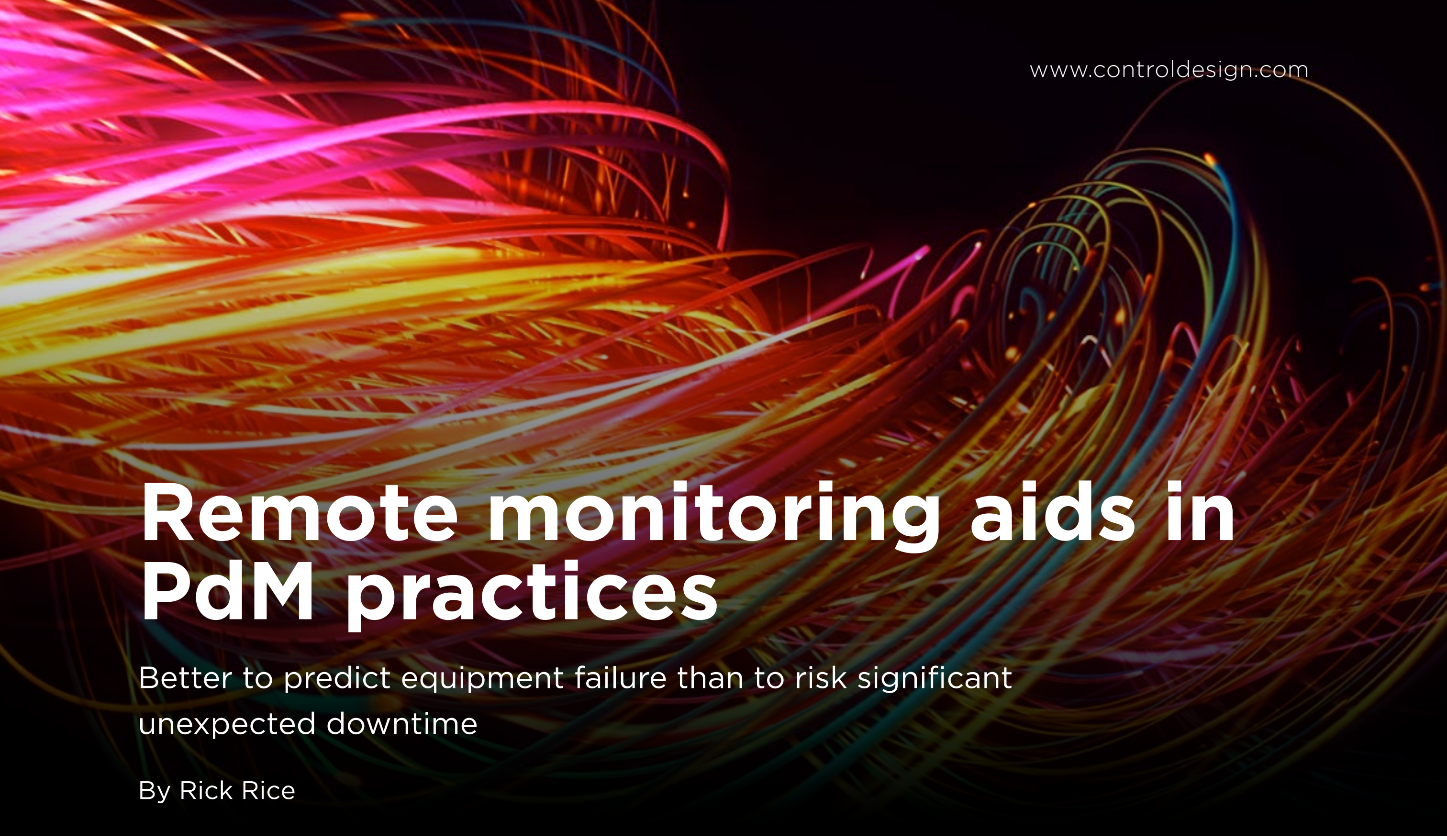
Welcome to the edge 15

AD INDEX

Beckhoff Automation 3

Hilscher North America 9

Wago Corporation. 14



Remote monitoring aids in PdM practices

Better to predict equipment failure than to risk significant unexpected downtime

By Rick Rice

Over the years that I have been writing for Control Design, the majority of my articles have focused on the deployment of automation. My view, from a guy in the trenches, is intentional as I would like to think that we are all in this together and sharing our experiences is for the good of all.

Deploying automation, however, is only half the story. Designing a control system, using the latest in technology, gives our machine or process a fresh breath of life, but what happens once the newness has worn off?

The general consensus would be that a new control system automatically provides a period of bliss where all the new components are happily doing their thing without intervention from maintenance. The more we build into the user interface of a system, the better we can identify what to do when the machine or process stops suddenly. If we plan it right, we will have some idea of what the machine was attempted to do when the unexpected stop happened, and hopefully we can use the various sensors in the process to tell us where the machine is in that sequence leading up to the failure.

While this might be enough to point us in the right direction as far as correcting the problem and resuming operation, wouldn't it be better if we could predict that a failure was going to happen?

Any time a machine isn't producing, personnel are tied up with trying to make it run again, and the company is losing money. For both the company and the maintenance team, a snapshot of the machine when the failure happened is of limited help. The sensor or actuator might be functional at the moment the snapshot happens but could degrade in operation immediately after the event.

The desire of all parties would be to have foreknowledge of the pending failure, with the benefit of being able to schedule maintenance during anticipated downtime to replace the component.

To put this into perspective, let's say that one of your maintenance team members notices that a conveyor is starting to get louder. With the pressure of trying to keep production running, a decision might be to make note of the symptom and plan to replace the noisy bearing closer to its fail point. The problem with this approach is: how long do we have? Is the bearing about to fail? Is failure two months away? When it fails, will it only be the bearing, or will it cause other components to fail in a more catastrophic way?

In the above situation, solving that eventual failure might be as easy as swapping out the conveyor for one of the same size and performance, causing a minimum of downtime.

Imagine, however, if that was the bearing on the main air exchanger for the plant? Waiting until failure could cost thousands of dollars to repair, not to mention the loss in revenue if production on multiple lines has to stop while the repair is being made. The risky nature of this type of situation has prompted the emergence of an approach to predictive maintenance called remote condition monitoring.

In recent years, the Industrial Internet of Things (IIoT) has brought sensor input to mean more than just the off/on or analog feedback from a device. IIoT is an extension of IoT (Internet of Things), which basically describes a world where everything is connected to the Internet

Software applications can access data provided by all the devices that are connected and provide information to a service. A control system, if connected to a network, can provide a means by which third-party software can access the devices in that control system and gather data that can be evaluated to provide analytical reports on the true status of the devices.

Implementing such a high-tech solution might not be as complicated as one might think. You might be surprised to learn that many of the common sensors you use each day in your control solutions are actually capable of providing more than just the analog or digital signal that you use it for.

The connection methods are just the same as you are using them today, but, if connected to a specialty module, such as an IO-Link master, it can open up an extensive list of data that can be used by a remote monitoring system. Some of the data includes the make and model of the device; network or node assignment; and operating parameters such as temperature, voltage and current, as well as performance data.

Sure, your digital sensor might provide you with a 1 or 0 to tell you if it is ON or OFF, but it can also tell you, for example, how long it takes to produce a result once the sensor is tripped in normal operation.

The great thing about performance data is that it can be used as an indicator of pending failure. An inductive proximity switch, for example, might normally take 0.3 ms to turn on and 0.7 ms to turn off. If the surface of the proximity switch starts to accumulate ferrous material or a nonconductive film such as oil, the response times will likely alter. This might have a negative impact on your control system. The result might be not completely seating a component in an insertion application or the collision of two actuators that operate in close proximity to each other.

Other good examples of sensors that would be helpful in condition monitoring would be vibration and heat sensors on bearings, or strength of signal on IR or laser photo-sensors.

Condition monitoring, however, doesn't have to involve an immediate leap into a cloud-based solution where third-party software takes all of the data from your networked devices, digests the data and gives it back to you in a report prompting you to do something.

It can start with add-on modules that have specific functions, for example, a blower monitoring module. These modules bring sensor data into a common location where a wireless or wired connection brings information to the attention of an interested party.

In this situation, the control system doesn't have to be able to read smart devices. The add-on sensor module does the job of getting the data analyzed. The user can set limits of normal operation and the module will alert to function that exceeds the set limits.

For those that elect to build control systems using smart sensors and actuators, there is a serious consideration that will impact how you use the myriad information that will suddenly be at hand.

There is a lot involved in just making the process or machine operate using your control system. It can take hundreds of hours to design the system and then develop the software applications for your PAC/PLC and human-machine interface (HMI) to interact with the controls.

The investment in the hardware required to take advantage of the smart devices for condition monitoring is an important decision, but an even larger investment will be made in developing the software algorithm and analytics necessary to make use of the additional information shared from your devices. The decision to be made is whether to commit internal resources into this objective or hire an outside firm to take care of that for you.

Fortunately, the advance of IIoT has prompted some specialty companies to offer up such services, and, in many cases, they have pre-canned solutions to offer in this regard. While a customized solution might be most desired, a cost-effective solution that offers the end user the opportunity to take the pre-designed solution and identify the important sensors and processes to be flagged is an attractive possibility.

A great side benefit of publicly offered solutions using smart-sensor data analytics has prompted many hardware providers to get into the remote monitoring game themselves. The advantage of being able to make intelligent decisions about when to execute predictive maintenance, based on live data from your processes, is obvious to most companies, and the investment that these companies are willing to make in this regard is hard to ignore. This has created a competitive market, and the number of companies offering solutions is growing exponentially.

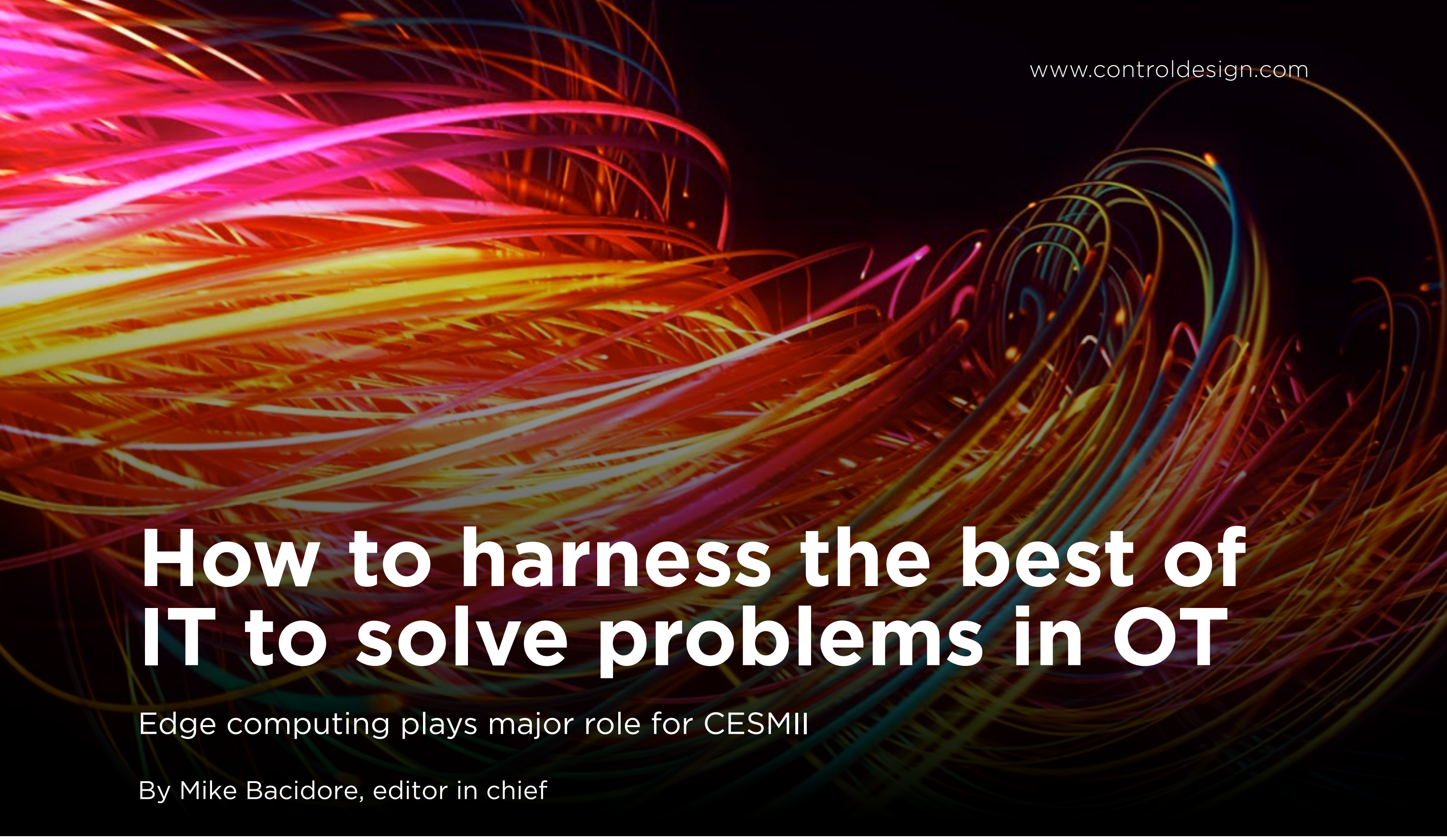
While the company I work for hasn't embraced remote monitoring as yet, we have taken a major leap forward just a couple of years ago by investing in a cloud-based data collection system for our production output. With much less investment than I would have originally predicted, we were able to get a wired network into all of our production areas and install basic smart relays (mini-PLCs) on each line to collect the basic data of product produced and cases produced at the end of the line.

The cloud-based system then takes this data and, using our production schedule data, produces data that tells us how well we are running. With some add-on features, we are able to engage the line operators in some simple button presses on a tablet to tell us their observations on the line to support the overall equipment effectiveness (OEE) information that is reported by the cloud-application.

It has been an eye-opening experience for us and helped us realize that we don't have to figure out a way to generate all these important decision-making tools in-house. Our hardware investment to get things going has already realized a significant return on investement (ROI) that we have turned back into additional applications on the base system to further enhance our performance.

> Our hardware investment to get things going has already realized a significant return on investement.

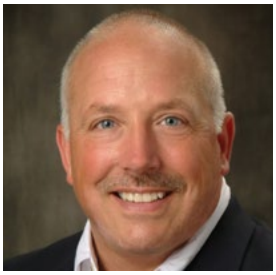
The bottom line here is: don't be afraid to investigate the potential of remote condition monitoring. It only takes one major equipment failure to make it readily apparent that being able to predict not just a future failure, but quantitative data to identify how soon that failure can be expected, is a very valuable tool in predictive-maintenance practices.



How to harness the best of IT to solve problems in OT

Edge computing plays major role for CESMII

By Mike Bacidore, editor in chief



Roy Kok joined CESMII as marketing director in August 2020. He has more than 30 years of experience in industrial automation, ranging across both hardware and software. His areas of expertise include data acquisition, PLCs, HMI/SCADA, historians and analytics solutions across all vertical industries. He has worked with research companies for industry and held evangelist roles for product companies and standards organizations. He plans to bring an extremely broad perspective of industry needs and position CESMII as the clear solution for enhancing the competitiveness of U.S. manufacturing. Kok holds a bachelor of science degree in electrical engineering from Northeastern University and resides in Massachusetts, either at his home or on his trawler, RyKa.

What are three key things that a machine builder, system integrator or manufacturer should know about your company?

Roy Kok, marketing director, CESMII—The Smart Manufacturing Institute (www.cesmii.org): CESMII is on a mission to change the world of manufacturing for the better, in one major step, the introduction of standards and example technologies to deliver application plug-and-play. The goal is to democratize smart manufacturing for all enterprises, large, but especially the small and medium companies that make up more than 98% of the market.

The opportunities of Industry 4.0 and smart manufacturing are largely out of reach, due to the cost and complexities of adoption.

CESMII is delivering technology, but also assisting customers with education and networking with peers that are on the same journey.

Every company, end user, system integrator and product vendor should become a member of CESMII, a government-funded, nonprofit institute specifically for their benefit.

What new technologies are driving your product development and why?

We're looking to deliver existing cloud-based technologies in ways that manufacturers can feel comfortable with, decreasing infrastructure costs, while ensuring security through modern encryption practices and safety by taking a read-only approach to machine learning and AI. We're also beginning to invest heavily in edge and hybrid scenarios, where appropriately managed compute services deployed at or near network boundaries can be orchestrated to solve more real-time problems. On the technology front, we are currently interested in edge compute, orchestration workflows, graph databases, semantic models, OPC UA and Industry 4.0 technologies such as Asset Administration Shell. ThinkIQ and Savigent, among others, have also played a key role in defining technologies and architectures.

How does the Industrial Internet of Things figure in your business strategy?

Clearly, the 4th Industrial Revolution technologies, with Industrial Internet of Things (IIoT) as a component is important to the whole world, and especially to us, as it is our mandate to make the benefits available to all. The primary challenge to adoption of Industry 4.0 technologies is that consumers are implementing with Industry 3.0 techniques. Most small and medium companies do not have the knowledge, time or staff to implement these solutions and reap the benefits. Hence a step change is needed to facilitate adoption. CESMII is working on modeling equipment and processes such that applications will be able to be installed at a site and will be able to discover the equipment and processes that they can interact with. While data models are becoming more prevalent in software, they are implemented in silos, in vendor-specific ways, and lack broad applicability. Most also lack the greater context that is needed for automated discovery and configuration. Most models are designed for user interaction—a system integrator performing the needed review and implementation. This needs to change if we are to enable the Industrial Internet of Things in a broadly applicable way. When CESMII accomplishes this, and it is just around the corner, then applications delivering predictive analytics, OEE, asset management, AI and ML will be commonplace and not the purview of the largest and most mature enterprises.

How will machine automation and controls alter the way companies staff their operations in the future?

The CESMII goal is to enable progress with minimal staff change. Through the enhancements in technology, delivered without the need for complicated installation and configuration, staff will be able to concentrate on the benefits of new functionality, and not hampered by maintenance of that functionality. This should lead to a boom in new applications. Vendors and system integrators will be able to focus on delivering new and truly valuable solutions to industry problems that will be able to plug-and-play, discovering items to analyze and automatically configure the delivery of their value.

How is the development of software solutions impacting your requirements for hardware?

It is hard to believe, but in 1965 we saw the introduction of Moore's Law, the prediction that integrated-circuit complexity would double every two years. That concept has been proven true and continues to this day. So, hardware is continuing to become more powerful, and, in the world of automation and analytics, it is now time for applications to catch up and make use of the hardware that is available. We are already seeing the prevalence of edge devices that are secure and ready to be vessels for new applications. Edge computing plays a major role in CESMII deliverables. We are also seeing the proliferation of secure and reliable cloud-based computing, again, a platform ready for the applications that need to be created and delivered. And again, CESMII is ready to leverage cloud computing is a very scalable way, ready for the small and medium manufacturers, but also scalable to meet the largest of the Fortune 1000.

As engineering and IT continue their convergence, which one is and/or will be leading the direction of future automation and technology at your organization?

Convergence may actually be minimized, and they will be focused on their strengths. In past years, convergence was required to deliver the collaboration needed for technology rollout. If technology distribution becomes simplified to the point where we see plug-and-play and have the ability to try before you buy, then we will see IT focus on technology and business metrics, and engineering will focus on what it should be focused on, improving the production and engineering of the product or service. Manufacturing needs drive our direction, but information-technology principles and ideas from computer science inform our explorations and implementations.

It is now time for applications to catch up and make use of the hardware that is available.

CESMII wants to harness the best of IT to solve problems in OT.

Looking into the future, how will technology change your company over the next five years?

Driving cleaner energy and smart manufacturing innovation is CESMII's present and future; technology is just one tool we'll use to try to improve the situation for U.S. manufacturers. Other tools include best practices, informed by our membership, open standards that we'll invest in applying and improving and workforce development through the democratized distribution of information and education for any member that wants to participate.

Welcome to the edge

Edge technology meets manufacturing head-on

By Jeremy Pollard, CET

Edge computing basically means taking the input/output (IO) constructs of a controller to the point of use with computational abilities. In a plant environment, that edge could mean the beginning and the end of a process.

Imagine a paper machine whose length could be in the hundreds of feet that has sensors and controls throughout the process.

Enter remote I/O, whereby the controller's sensor and control points are taken to the area of control and tied back into the controller using communication techniques such as Ethernet/IP or Profinet. Even Wireless HART gets into the action by communicating with the controller over the air.

But is remote I/O the same as distributed I/O?

I remember back in the 1980s when a newfangled technology was being introduced by Rockwell Automation, and it was called distributed control. The devices that made up part of the network were intelligent, and these devices made decisions based on its programming.

It was a sorting application using different-colored ping pong balls. Once the color was determined, it sent a direct message to the sorting sensor. Imagine it being like an inverted Y with a diverter to direct the ball into the proper tube.

The sorting sensor detected the ball as it entered the diverter area, and knew the color therefore alerting the control element (diverter) to move one way or the other to properly divert the ball. This sorting sensor told the diverter that a ball was present, and which direction to move, and the controlling element solenoids did the rest.

There was no central PLC or controller in this system, which for that time was heresy.

The main reason for having remote or distributed I/O was to cut down on installation time and cost. Taking the I/O to the sensors and controlled elements meant less wiring but also meant that troubleshooting required a steadier hand since all the I/O lights and modules were not in the same place.

The need for software became more obvious for troubleshooting and starting up the system.

In today's world distributed I/O is ever-present regardless of implementation of control strategy. Discrete and process both benefit from communication networks and third-party I/O suppliers.

EtherCAT, Ethernet/IP, Profinet, Wireless HART and ModbusTCP are examples of the connective tissue needed for distributed/remote I/O, which can lead to smart devices and brings us closer Rockwell's distribute-control mindset.

IEC 61499 is very supportive of systems that have no controller. It is defined as a system-level design language for distributed measurement and control systems.

It is based on the notion that devices can house and execute event-driven function blocks from within the device itself.

I first ran into this standard in the late 1990s and in fact spoke with a pioneer at Rockwell whose name is James Christensen while I was the managing director for PLCopen. IEC 61131 was having all kinds of trouble entering the North American market, so who would have thought that another IEC standard would gain any traction? What a difference a couple of decades makes.

The idea of function blocks is definitely more accepted in this day and age. Process people have been dealing with them forever, but, with IEC 61131 software becoming more prevalent and add-on instructions in many PLC offerings becoming the norm, function blocks are a known quantity now.

The IEC 61499 function block is similar to a normal function block but with an added event input and an event output. The construct of the block allows for a state-

Discrete and process both benefit from communication networks and third-party I/O suppliers.

driven algorithm that is executed using transitions.

The algorithms can be programmed in any IEC 61131 language including other function blocks and are objects from a software point of view.

From a hardware standpoint, even the Raspberry Pi can get into the action. PLCs of course are also able to support IEC 61499, but the actuators and sensors that can be connected together. True distributed procession through direct I/O will have its place in the sun in control systems of the now and in the future.

Working with Rockwell's CompactLogix platform, which supports electronic data sheets, allows third-party vendors to provide the PLC with a catalog entry in order to support the hardware. Vision cameras and the like also are easy to implement using the electronic-data-sheet catalogs. In Rockwell's case Ethernet/IP is the connective tissue that makes things work. Beckhoff uses EtherCAT, but the results are the same.

Remote and/or distributed I/O makes installations much easier. It reduces costs, but requires higher levels of monitoring and troubleshooting skills. With software, however, that part should be easily overcome.