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Who put the mouse in control?

How PLCs, PACs and PCs all come from the same inspiration

By Rick Rice, contributing editor

Recently, I was on vacation with my wife in the "happiest place on Earth"—Walt Disney World in Florida. Last year was a write-off for most of us, dealing with a pandemic of epic proportions. For some, like myself, Coronavirus D-19 (COVID-19) was personal. I started getting sick in early August 2020 and, within three or four days, found myself in an intensive-care-unit (ICU) ward at our regional hospital. Through shear willpower, I managed to stay off of a ventilator but still spent 15 days in a COVID-19 ICU before finally moving up to a ward for another three days of recovery. While there are some lingering issues, for the most part I am past all the bad stuff and happy to be alive.

There is a stark contrast between last year and this year that I can barely put into the proper words, but I think I can best describe myself as a survivor. I truly hope that all of you can say the same as we continue to deal with this specter, nearly two years after it first began its march around the globe.

My wife and I spent the day at the Magic Kingdom. It has been a tradition for her since 1972 and became a part of my life when I made my first visit about eight years ago. For most who visit this magical place, the lasting memories are of the attractions and all-encompassing hospitality that is Disney. I would suggest that no one does it better. While I had an awesome time, I found myself doing what I always seem to be doing. I was thinking about automation.

For those who know me personally, I'm sure you would think nothing less of me. It has been my life for more than 30 years, and I really can't lay my head down at night without some level of automation thought process in the pipeline to Neverland.

While my wife was happily sitting beside me through It's a Small World, The Haunted Mansion and The Hall of Presidents, I was drinking in all of the wonder behind the scenes. For instance, how did all of the various characters in the small world all move along in time with the song? What magic was at work to keep them all in sync?

The most amazing of the Disney marvels, at least to me, is the automatons in attractions such as The Hall of Presidents. They are so lifelike, and their motions are perfectly choreographed into the presentation of the story that takes us from George Washington through the most recent president. The answer, of course, points back to programmable controllers.

I'm sure much has changed over the years, but the approach really hasn't changed at all. The Carousel of Progress, for example, was first introduced at the 1964 New York World's Fair.

The premise of the attraction is to chart the history of innovation, starting with the invention of electricity and how all of the wonderful discoveries over the generations has brought us to where we were today. Now, as one can imagine, the original attraction at the World's Fair covered roughly 60 years of technological progress. The attraction gets new updates periodically to keep it current—the most recent one was in 1993 and features a final scene suggesting what Christmas would be like in the year 2000—but just imagine how much has happened since that 1964 premiere. Why, there wasn't even a device called a programmable logic controller (PLC), and yet in 2021 we couldn't do what we do if it wasn't for that magical little device and its offspring, the programmable automation controller (PAC) and the programmable computer (PC).

It might surprise some to learn that the first programmable computer, the electronic numerical integrator and computer (ENIAC), was actually built during World War II, roughly 20 years before that Carousel of Progress came to life. The journey, it would seem, started long before many of us were born, so, as it turns out, one of the children mentioned above is actually the parent.
I lingered with the theme of The Carousel of Progress because it really drives home the point that there is a lot to be proud of when it comes to technological innovation. It's not much of a stretch to say that, with the exception of Nicola Tesla, most of the earlier inventors, such as Thomas Edison and George Westinghouse, had no idea that their work would lead to the wonderful inventions that we use today.

Tesla, for me, remains the tip of the sword when it comes to what lies before us. Truly a visionary. The light bulb, for example, seems commonplace today, but what an illuminating—pun intended—discovery it was for that time. Since then, we've seen ringer washers, electric ice boxes (refrigerators), radar, televisions, personal computers, wireless communications, a thing called the World Wide Web and now a device that you can hold in your hand and connect to that World Wide Web via a wireless network, giving you access to the knowledge of everything that mankind has ever done ever.

PLCs are, perhaps, becoming a legacy device. Much more powerful, the PAC is a wonderful melding of the logic controller with the sibling—or is it parent?—PC. The more recent version of a PAC can combine logic and safety in the same physical device. Some even have dual processors, with one dedicated to logic and the other to strictly safety functions, providing a truly integrated device.

I have been lucky to stop a couple of times along this journey of discovery and pick up a few programming languages. While I fear that I have fallen behind in this, there was a time when COBOL, FORTRAN, C and its many iterations, Visual Basic, Pascal and Prolog were the lights spinning in my mind each night. I have always thought they were distinct beasts from the ladder logic and statement list of a PLC.

Reluctantly, I can no longer say that this is the case. I have always realized that true programming languages were far more powerful than the representation of an electrical circuit—ladder logic. I really didn't come across a reason to jump over into the realm of structured text. This probably happened because my focus has always been on the moving machinery of automation and not the land of process control.

The journey, it seems, has come full circle. With the continuing development of the PAC, control algorithms are no longer restricted by the use of ladder logic.

Most PACs include either modules or core memory space to program in a structured text environment. Complex programs and subroutines can now use a combination of higher-level languages and good old ladder logic.

This has led back into the world of programmable computers where structured text has formerly reigned supreme. If one doesn't need a physical device built to live in a manufacturing environment to control a machine or process, then the PC is the next logical choice in the evolution of control. With all that said, I think the demise of the PLC and, eventually, the PAC are far off yet. We humans are strange creatures. While we embrace a vision of the future, we tend to hold on to the past. After all, why fix it if it isn't broken?

There was a time when COBOL, FORTRAN, C and its many iterations, Visual Basic, Pascal and Prolog were the lights spinning in my mind each night.

I'm afraid I am a contributor to this tendency to lag. I take great pride in creating control systems that can do all of these wonderful things, all the while knowing deep down that the same things can be done with the newer technology in shorter time and probably at less cost.

One recent example of this for me was the discovery of an instruction in my favorite PAC that provides a direct link to an object, for lack of a more sufficient term, on the operator station for alarms and tagging.

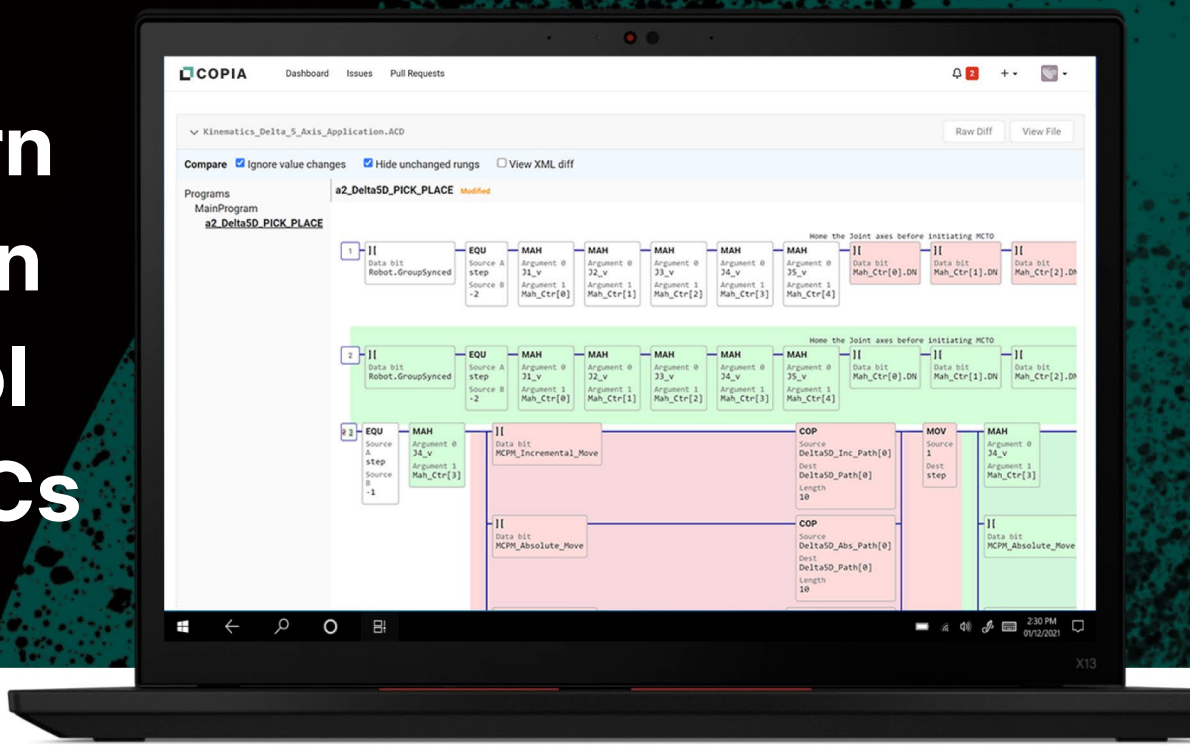
The darned thing lets you put all the logic in to not only trigger the alarm but disable it when desired, ignore it when desired and group it with other alarms of a similar type or scope. The programming instruction even has a string tag for the actual text that will display on the operator screen.

I've come up with some creative ways, over the years, to make my controller and operator screen interact in such a manner, but, I confess, it took me hours of coding to accomplish. I've always been proud of this ability but I now realize that I've ignored this "new" technology for several years while I was mired in the "if it ain't broke, don't fix it" mentality.

While I am often inspired by technology, this particular column was inspired by a man who, at his lowest point in his life, was reduced to living in an abandoned room where he made friends with a little mouse. That mouse would one day become a symbol of one of the largest corporations on Earth.

Inspiration is always out there if we are willing to look beyond what we see and begin to envision what can be. The spinning carousel that is progress is perpetually reinventing itself. The world that saw a computer that was the size of a room become a device that fits in the palm of your hand will continue to provide evidence of the evolution of mankind. What will be your inspiration?

Modern version control for PLCs



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PLC options for code documentation

Program documentation, revision control, rung comments or troubleshooting functions need to be clear and descriptive

By Anna Townshend, managing editor

A Control Design reader writes:
When programming, what is the best approach for documentation of the code?

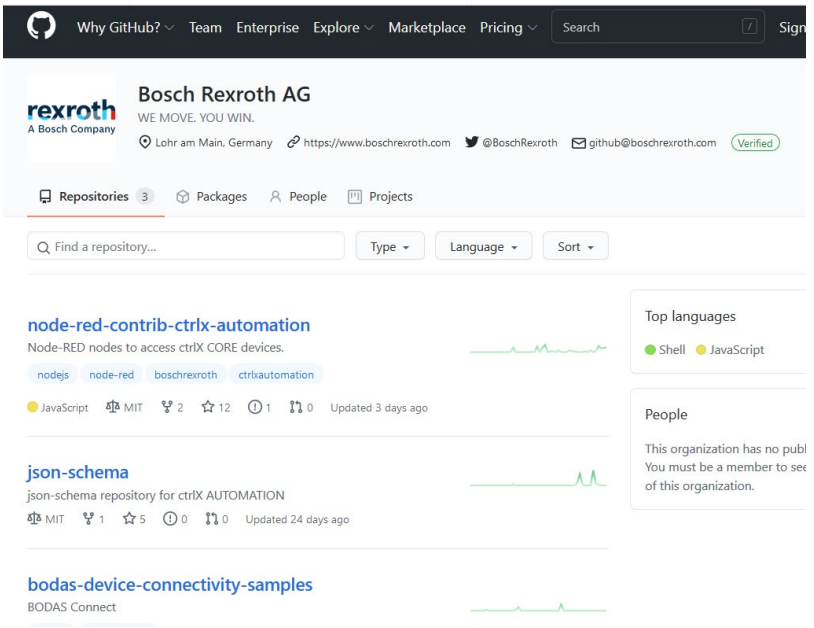
ANSWERS

FOLLOW THE RABBIT TRAIL

You could say that proper program documentation is in the eye of the beholder. It is a rather subjective topic, but the overall goal is to communicate the intent of the machine level instructions used in programming environments. Well-written code can be self-documenting in some respects, but this usually requires familiarity with the programming language. The language of programming is built for efficiency, not necessarily easy readability, so it often becomes necessary to add documentation to provide more context or to communicate intent of code design. Revision control provides an historical documentation that is valuable to keep track of enhancements along the life of the code without polluting the code with too much text.

Program documentation can happen within the code itself using documentation features of the integrated development environment (IDE). For ladder logic, that might mean commenting rungs of code or headers for programs or tasks. For text-based code, it is simply 'commented out' lines within the code itself. The comments leave a rabbit trail of impor-

tant functions within the actual code. It is useful to explain certain functions and help someone who is following the code to know how the code works. It is particularly useful to explain calculations that might not be apparent from the data points that are collected in the program. Naming conventions of data points and variables help to make the code easier to write and more efficient to read, as long as the naming convention is documented for the next reader.



Revision control is important to understand the history of the code, documenting changes along the way. Major updates and revisions can be tracked to assist in troubleshooting if some problem is discovered later. A record of new feature additions can be recorded to see when new functions became available. Revision control provides a base structure for branching into different sets of code that have different functions. GitHub is a popular website for managing version control using Git, an open-source software used in Linux since 2005. It is one of the most popular repositories of source code in the world and widely used in the software development community. As industrial controllers move more toward using the tools

of modern, non-industrial software development, revision control tools like GitHub are being integrated directly into industrial programming IDEs.

Allen Tubbs / product manager/ Bosch Rexroth / www.boschrexroth.com/en/us/

HOW INPUT AFFECTS OUTPUT

Proper documentation of code depends on the documentation's eventual use. If the purpose of the documentation is to help with troubleshooting, then I would first recommend investigating the type of code being used. Ladder code is great for troubleshooting because it easily helps engineers to see how inputs are affecting outputs. Sequential function charts are another great option for troubleshooting. They can provide intuitive visual cues to where the logic is at and what the code is waiting for to continue.

Whatever the purpose of the documentation, it is always imperative to be mindful of the audience. Documentation should be written in a way that clearly translates the code in plain language. Simplicity is the name of the game—the goal should be writing the documentation as if you were explaining to an elementary school student what the block of code does.

Kris Dornan / marketing manager, Logix controllers / Rockwell Automation / www.rockwellautomation.com

BREAK THE CODE

This changes greatly with the type of code that you are doing. In general, if you can give very descriptive tag (variable) names and give your function instances descriptive names you have made very readable code. To get more specific, for PLC code I would place a rung comment on each significant rung. By this, I mean when you move from controlling one part of a system to a different part, document that change with rung comments. For more of a text or SFC type program, you have a lot more flexibility in your

documentation. Here I would suggest that you break your code into chunks that are well described so that you can debug starting at where the problem is evident and work through the chunks that contain the source data. Really, as far as the best practices for program documentation go, as long as it is there and the variables are understandable any further tips inside the code is icing on the cake for the next programmer to enjoy.

Mark Russell / tech application support manager /

Allied Electronics & Automation / www.alliedelec.com

MULTIPLE PROGRAMS AND LANGUAGES

First things first. Ultimately, PLC code is used to control a machine or system. Therefore, the goal of documenting any PLC code is really about documenting the machine or system, and documentation begins during the system design phase. System documentation should describe the overall architecture, configuration, I/O wiring diagrams and what the system does. Clearly defining the system also gives you a clear view on structuring the PLC program.

PLCs are very flexible and allow you to structure a PLC project as multiple programs, each of which can also be broken down into smaller units. For example, you can have an initialization program to load parameters on power-on, and a separate program for executing the main routine of the system. Clearly define the names of these programs and what each program does. Also define your variables. A table of variable definitions provides important context for anyone looking at code.

There are also some standards that exist to help provide standard structure and terminology. For example, Mitsubishi Electric is able to provide PackML sample projects with defined machine operation modes and state transitions.

> Simplicity is the name of the game—the goal should be writing the documentation as if you were explaining to an elementary school student what the block of code does.

During the design phase, you also have a choice of programming languages between ladder diagram, function block diagram, structured text and sequential function chart. And it doesn't have to be only just one. A single PLC project can be comprised of multiple programs written in different languages that best suit the particular purpose. When programming in ladder diagram, add rung comments. Function block diagram, structured text, and sequential function chart languages allow for comments to be written anywhere. Take advantage of this to clearly describe what the code is doing.

With PLCs and increased memory capacity, the comments also stay with the code when downloaded to the PLC. This is a great benefit because even if the original project file is lost, you can retrieve the code and comments by uploading from the PLC.

In the end, the purpose of documenting PLC code is to make sure that the code can be maintained, so that programmers, technicians and customers can troubleshoot, modify or add to the program as desired. The easier it is to understand what the program is doing, the easier it is to support.

Lee Cheung, Sr. / product marketing engineer / Mitubishi Electric / us.mitsubishielectric.com/en/

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Control your design

How will you program your machinery control in the future?

By Rick Rice, contributing editor

I participated in the 2021 PMMI Executive Leadership Conference. PMMI stands for Packaging Machinery Manufacturers Institute and is now known as the Association for Packaging and Processing Technologies.

It is a community of machinery manufacturers, and the event I am honored to be selected to attend is a yearly gathering to put the executives of packing-machinery manufacturers together with executives from the world of consumer-packaged-goods (CPG) manufacturers.

Unlike the previous events that I participated in, such as the Top to Top Summit in 2017, this event was an all-virtual event. While I have participated in other virtual meetings, this experience was the first time where there was an audience in attendance.

Generally, I am not a fan of the virtual event. I do acknowledge that the still-present pandemic has altered the way we normally conduct business, but I do find that virtual events for me just don't cut the mustard. I suppose I am old-school but I do like to see people in person.

With my proximity to Chicago, I am fortunate to be able to catch the trade shows when they cycle through the city, and I very much look forward to the years when they are here. PackEx has always been a feature event for me. My years as an OEM/integrator has blessed me with a long list of former colleagues and vendor partners, so my attendance at this show

is as much an opportunity to reconnect with old friends as it is an opportunity to catch up on the latest technology.

Working now with a manufacturer of consumer packaged goods, my background with the packaging-machinery manufacturers gives my employer an advantage when it comes to selecting partners to help us along the automation journey.

As one can imagine, when participating in a leadoff meeting with CPG manufacturers and machinery manufacturers, there were a lot of questions about the state of the industry. We fielded questions about the increase in demand for our products, working remotely, the prospect of allowing a machinery vendor to remotely access our packaging equipment and the impact on the supply of components during a pandemic.

Two interesting sidebars came out of this kickoff session. First, right in the middle of a pandemic, a major automation hardware vendor had learned of a vulnerability via an Ethernet connection to its processors. Second, as a direct result of the pandemic and mirroring the impact that we all seem to be experiencing right now, having to temporarily shutter manufacturing plants due to loss of employees or virus transmission protocols, there is a worldwide shortage of the computer chips used in automation products.

Both of these situations can make a serious impact on the decisions made while designing and, importantly, choosing which control software will be used to operate the machine or process.

The control of automated processes has changed a lot over the years. One might immediately think of the programmable logic controller (PLC) for automation control, and that would be reasonable. First introduced to the automotive industry in 1968, the Modicon 084 would be the ground-zero moment for programmable controllers and a ground-breaking event for General Motors, the client for that first project.

Designed by Bedford Associates, it was their 84th product, and the 84 moniker would be carried through all the successive generations of that venerable product line. One of the lead engineers on that project, the late Dick Morley, is affectionately acknowledged as the father of the PLC.

The key element in the early PLCs was the use of a programming language called ladder logic. Hardwired, control-system schematics resembled a ladder where the rungs represented the steps of logic that made up the control. Ladder logic followed the ladder format where inputs (switches and contacts) closing, directed power to flow from the left side of the ladder to the right where the outputs (relays, timers, contactors, valves) would reside.

The benefit of ladder logic was that, while switches and relays came with a specific number of contacts, computer logic did not. You could use as many input or output contacts as you needed to make the control algorithm work.

Behind the scenes of every programming interface is an assembler that converts the human readable code into executable machine code (chip level). As powerful as ladder logic can be, it has limitations. The created algorithm is only as sophisticated as the elements that are available to the programmer.

Normally open, normally closed, latching relay are terms that are used to describe the visual symbols that ladder logic provides. Timers, counters, math functions make the ladder logic more elaborate. With all of these, the assembler still has to translate that logic into machine code to download to the processor.

Early on in the evolution of the logic controller, hardware manufacturers realized that, while the ladder-logic interface could accomplish a lot, being able program in something much closer to the finished (assembled) machine code would provide a far more powerful means of programming.

Some hardware manufacturers provided a pseudo-programming method by providing a means to enter code in mnemonics. Mnemonic code is a textual representation of the ladder logic. For those who are handy with a keyboard, mnemonic code can be entered at a much faster rate than picking symbols out of a toolbox and then entering the memory address to be used with it.

As most of us are aware, the development of the personal computer (PC) paralleled the development of the programmable logic controller. Some might remember early code development for a PC using a language called Basic. Other more powerful languages such as Cobol, Pascal and Fortran all existed around this time. These programming languages have something in common in that they used structured text (ST) to format the way in which the code is represented on the screen. Over the years, more powerful versions of ST programming languages have evolved to the point where we are at a crossroads in the programming of a control system.

The latest technologists and engineers coming out of our educational institutions are already familiar with structured-text programming, and it seems like a step backward to have them learn what must seem like the archaic ladder-logic programming technique.

Without naming names, it is safe to say that all programmable-controller manufacturers have directed their product evolution to accommodate the “archaic” world of pro-

grammers such as myself who have gotten very creative with the use of ladder logic while opening up the architecture to permit the use of structured text in everyday programming opportunities.

While it is clear that the hardware folks are making every effort to keep the old-school programming method available, it is clear that there will come a day where it will become necessary to abandon ladder logic in order to use the advanced features only available via structured text.

You'll find industrial computers that can communicate directly with I/O systems—the same I/O systems that previously were part of the backbone or chassis of a PLC-based system. These soft PLCs allow for the inclusion of other software to run concurrently with the control algorithm.

Commercially available software for things such as inventory control or code printers can run and interact with the controller program in a seamless system that eliminates the need to develop code in a PLC to trigger the operation of a printer or database retrieval program.

You will find PLCs have evolved into programmable automation controllers (PACs) to signify the inclusion of programming means other than ladder logic. You will find PACs that include an embedded but independent safety controller.

Finally, servo drives now include a logic controller so that a separate PLC or PAC is no longer required to control a system.

The method by which we control a machine or process is no longer a limited field of choice. We can stick with a ladder-logic-based system. We can choose a hardware platform that utilizes structured text. We can choose a programmable automation controller where we can use a commercially available programming software to create our control algorithm. If we are more comfortable with programming in a servo controller, we can now choose to stay in that comfort zone and control our entire machine or process with the servo controller and the central control point.

It's important to consider the end user in this process. While the choice of structured text or commercial programming software such as C++ or others might be the quickest way to get to the desired solution, some end users may not be equipped to support a control design that uses this approach.

Ultimately, we are selling a solution to a client and their comfort with the solution is an important consideration with implications after the sale.

I also alluded to the now, very real impact of a shortage of chips and what it does to control design. The selection of a control software may depend, at least for the near

More powerful versions of ST programming languages have evolved to the point where we are at a crossroads in the programming of a control system.

future, on the availability of the hardware platforms that we count on.

The common lament from both CPG manufacturers and PMMI members was the direct impact on the ability to meet deliveries and project timelines. Many manufacturers make their own control systems in addition to working with machine vendors with their control systems.

How long this backlog will exist is the greatest question in the controls industry, but it surely will have a lasting impact on how we go about control. If we choose, for instance, to go with a servo with embedded controller because we can get that hardware today, will we go back to the more conventional means of a PLC/PAC controlling a system?

Will we, instead, jump into the soft-PLC platform on the assumption that industrial computers won't suffer from the delivery issues that currently plague the PLC users? The world is changing, and, perhaps, the days of ladder logic are over. It will be important to make sure that the vendors of control systems are ready to provide greater support to their clients while we transition through this journey from PLC to IT. It's sure to be an exciting time for all of us in control design.

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Immediate gratification comes to control

Big data and IIoT can bring answers where you want them faster

By Jeremy Pollard, CET

Under what circumstances do we stop using PLCs and PACs? Will we ever stop? What creates the need to migrate away from them, and/or why will we stay with them?

These are things that make you go, “Hmmm.”

I was on a conference call with a network company who was trying to figure some of the future out. Good luck with that, I thought. They sent me a list of questions that they wanted to talk about and my first reaction was to forget about it. Our industry reacts in years, not months. Processes don’t change overnight, and products are only new and improved based on packaging. They sell this as a feature, but in reality there is less product in the new package.

But I digress.

Do you know what a Kubernetes is? Well, I didn’t, so, with Google by my side, I discovered that it is a computer application that is a container system for automating computer application deployment. Could part of our future be deployment of SCADA/HMI and PLC/PAC applications?

There is really minimal difference between the PLC/PAC world and the computer world, except for packaging. The newest ControlLogix PAC from Rockwell Automation has four environments as part of the hardware, which means that one of those environments can run computer-based software such as Windows 10. That means that the HMI, such as Inductive Automation's Ignition or FactoryTalk View Machine Edition, could run locally on the PAC without the need of a secondary computer, much like Opto 22's Groov.

I have heard from various visionaries about a software-based PLC that could run in the cloud and thought that, while this innovative, they are really just nuts. There's no way in the world I would ever run control software over the Internet.

But wait. We run control networks over Ethernet, so where's the difference? That's for another column.

We have continually believed and developed applications for the least common denominator, which is the maintenance department at 3:00 in the morning. This is meant as no disrespect to those who man those departments, but more of a mention that the job is the hardest on the planet at 3 AM. In order for them to be successful with minimal support at that time in the morning, they need to be very familiar with the systems that are in place.

Typically the technology changes are incremental, not orders of magnitude, because of the 3 AM demons. The engineering person will develop and design based on not wanting to be called at 3 AM to help solve a problem.

Note that remote access and remote monitoring with the Internet has moved the goal posts, but no one want to have disrupted sleep.

Our systems are going to become much more complex as we move forward. The PLC/PAC will still be the mainstay of the control spectrum, but, based on the questions I was asked, there are people out there who want to play in our sandbox and take things to a totally different universe.

One question I was asked was whether customers in general feel comfortable in using Raspberry Pi single-board computers to run single-source applications? My answer revolved around fixing versus replacing.

A maintenance electrician will typically know little about fixing a Raspberry Pi device with I/O and communication outboard modules. But he will understand that it has failed if told or has the ability to discover it has failed, and replace it with another black box. Could PLC/PAC environments come to that? Will knowing the programming software become redundant? While I don't think so in the short term, where we might be in 10 years escapes me.

> We have continually believed and developed applications for the least common denominator, which is the maintenance department at 3:00 in the morning.

There was a large emphasis on IIoT and all things IIoT. What are they using and what use cases are most prevalent? IIoT is not concerned with refrigerators and stoves here. They are stand-alone valves and sensors that have the ability to be edge devices as well since they can compute and communicate with upward mobile platforms such as PLCs but also the cloud.

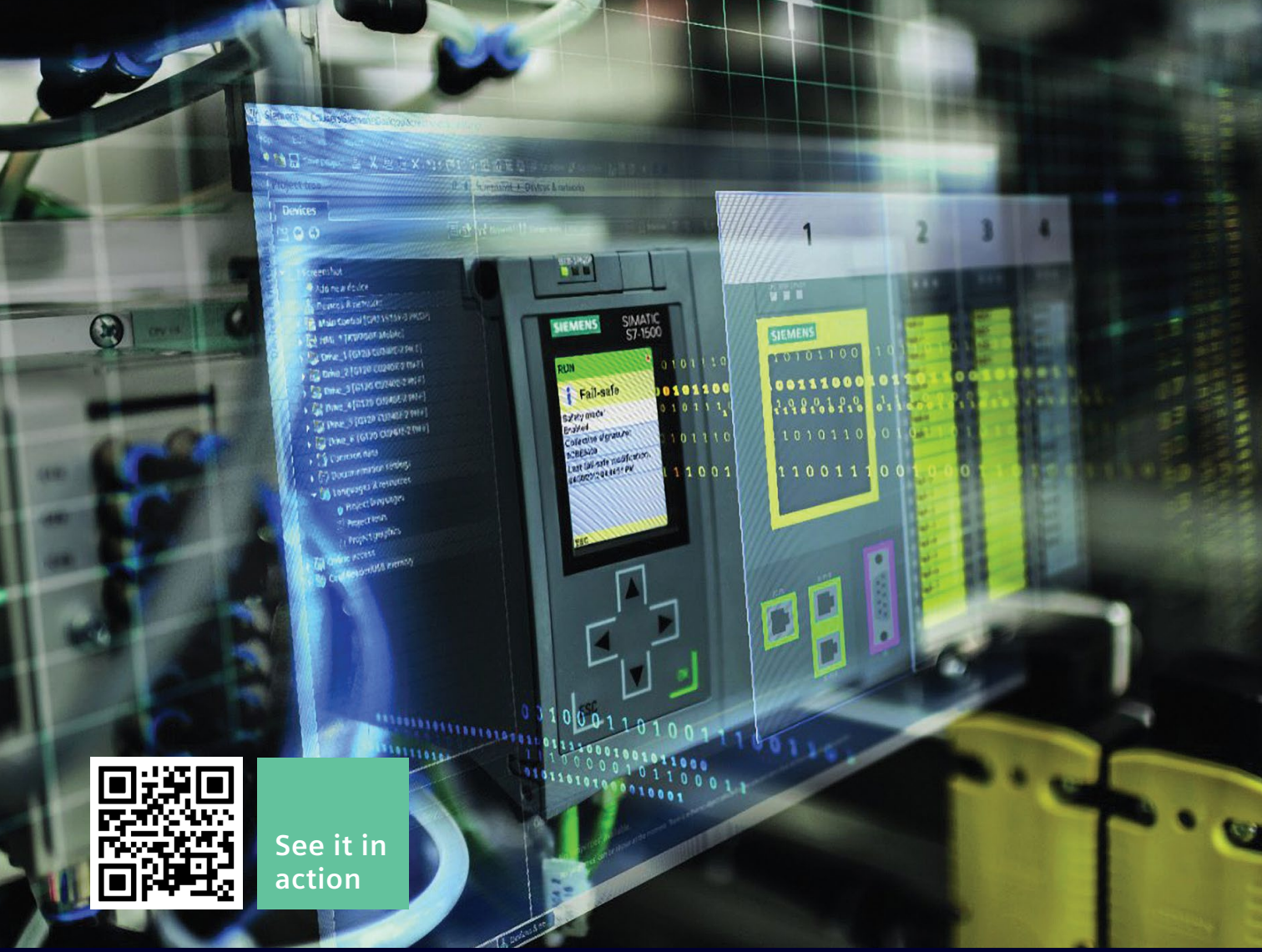
Can a PLC provide the analytics required for this modern-day phenomenon called big data? Do we need SCADA systems to provide additional use cases along with simple graphic interfaces?

Or will the PLC/PAC develop into an analytical machine along with control? The aforementioned ControlLogix can run analytical software along with HMI code with the PLC program all in the same box at the same time.

Real-time analytics will be a buzz term for years to come because we all want to know right now. Five minutes from now may be too late.

I fear that the role of the PLC is going to become so much more important than it is now, which will take a better-trained maintenance department, or at least a better troubleshooting environment, which may include the engineering department as a core component of that environment.

We are moving fast. Long live ladder logic.



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PLC change moves manufacturer along its Industry 4.0 journey

Global automotive supplier migrates automation and controls, realizing immediate benefits in costs and time

By Bill Taylor, BWI Group

BWI Group is a global Tier-1 supplier of suspension, brakes and chassis components to many of the automotive manufacturers around the globe. BWI has manufacturing sites in China, the Czech Republic, Poland, the United Kingdom and Mexico and its U.S. production facility in Indiana is expected to create almost 500 new jobs (Figure 1). Rapidly growing customer sales and increasing volumes with existing programs is what drove us to build the new manufacturing facility close to our North American customers. Aggressive program and project schedules combined with pressure to reduce equipment costs created the environment for BWI Group to look for strategic partners.

INDIANA WANTS ME

Figure 1: BWI has manufacturing sites in China, the Czech Republic, Poland, the United Kingdom and Mexico and its U.S. production facility in Indiana is expected to create almost 500 new jobs.

SELECTION COVERAGE

Figure 2: BWI Group's selection process considered costs and usability of hardware and software with an eye toward improved support and training, as well as meeting key metrics in the reduction of costs and downtime.

A thorough analysis of the market leaders concluded with our desire to work closely with Siemens to tailor the latest automation technology to our needs in the BWI facility in Greenfield, Indiana (Figure 2). Our selection process considered costs and usability of hardware and software with an eye toward improved support and training, as well as meeting key metrics in the reduction of costs and downtime.

BWI's strategic partnership with Siemens Automation for our Greenfield facility reduced the required investment in machine control systems, reduced the cost to support the production floor and will reduce downtime and lost production, which directly impact the profitability of the facility.

BWI Group has added manufacturing capacity quickly and cost-effectively to fulfill large new orders by deploying a wide range of Siemens automation, drives and communications solutions that resulted in cost and time savings, plus responsive support on the BWI 4.0 journey.

DEEP ROOTS

With roots going back to the dawn of automobile age, the BWI Group (www.bwigroup.com) is a top-tier supplier of chassis, suspension and brake products to the automotive industry worldwide. Customers include nearly all large auto manufacturers. With headquarters in Beijing, China, the company has more than 5,000 employees and 16 technical centers and

factories worldwide, and annual sales fast approaching $1 billion.

Its rich history started in Dayton, Ohio, where Charles Kettering invented an electric car starter in 1908, eliminating the sometimes-dangerous hand-cranking motors. Kettering's Dayton Engineering Laboratories became known as Delco. It was eventually bought by General Motors and folded into the Delphi parts company that was spun off in 1999.

In 2009, the BWI Group acquired Delphi's suspension and brake businesses, adding those to its existing chassis business.

Like many companies around the world, the BWI Group has embraced the Industry 4.0 vision of smart factories. In fact, it launched an internal, transnational initiative called BWI 4.0 to start its journey toward realizing the benefits of smarter factories for customers, as well as its own bottom line.

We want to take greater advantage of digitalization, such as integrated automation, digital twins and Internet of Things, so we can make faster decisions based on real-time or near-real-time data to improve our quality, efficiency and costs, while delivering ever-more value to our customers.

UP TO THE CHALLENGE

Adding manufacturing capacity quickly and cost-effectively to fulfill large new orders can be challenging. The BWI Group is growing fast, thanks to several large new suspension orders from U.S. customers that planned new manufacturing programs. To fulfill those orders, however, the company needed more capacity that was closer to customers in the U.S. market.

Because our North American customers operate lean manufacturing systems, which require just-in-time inbound logistics, it made sense to build a plant closer to their Midwest U.S. factories.

So, management decided to locate the new plant in Greenfield, Indiana, 25 miles east of Indianapolis. With U.S. labor costs higher than its other North American plant, the new plant had to be highly automated and extremely efficient to minimize operating costs. And, to minimize capital construction costs, the mandate was straightforward: reduce machine costs by 25%.

That was a tall order for our manufacturing engineering group. The new plant would have as many as 300 machines, large and small, from as many as 100 different builders. Of course, we'd have to work with each one to drive down our costs, but we also had cut the costs of our control systems. It really forced us to rethink how we do things.

And time was of the essence: Some of the customer programs had their schedules advanced by a year, which compressed our schedules by that much, as well.

AUTOMATION RANGE

Having worked nearly 40 years in automation and controls across several different industries, I had extensive experience in the solutions portfolio of a U.S.-based automation provider. In fact, many of its products were installed and operating at our company's Mexico plant.

But my allegiance to the supplier had waned after it responded poorly to a series of support issues. When a machine or production line goes down in our plants, our delivery commitments to our customers are immediately put at risk. If we don't deliver when we say we will, their production can stop, potentially costing them lots of money, and that's a huge mark against us. So, getting slow or ineffective responses to issues with their products was totally unacceptable.

SEEDS OF UNDERSTANDING

We decided the new plant was an opportunity to evaluate Siemens automation, controls and connectivity solutions, with which I was somewhat familiar. Two years before, my curiosity about the future of automation and controls engineering prompted me to attend a two-day Siemens modernization workshop. I wanted to find out what advancements Siemens had and what benefits they might offer, as well as what it would take to migrate from our current automation supplier.

We have Siemens PLCs and other components in our other plants in Europe and Asia, so it was a chance for me to learn more. The workshop was led by former employees of our then-current automation supplier, so they spoke my language, knew my concerns and helped me understand how Siemens could help me address them.

With that basic understanding, and now with a chance to explore actually converting to Siemens, we called Siemens and its local automation distributor, C&E Sales, to find out more information and discuss options.

BIG SAVINGS SURPRISE

We discovered a welcome surprise, especially given the cost mandate. Siemens hardware was as much as 40% less expensive than our other automation products supplier, and software was less than half the cost. But as much as I liked the cost savings, the engineering and technical support was just outstanding, leading us to execute a global partnership with Siemens.

As the Indiana plant was built out, we found that support invaluable in planning automation, controls and connectivity. Among the Siemens components selected:

- Simatic S7 PLCs, including S7-1500 and S7-1200 safety- integrated models, plus ET 200SP for distributed I/O

- Simatic HMI Comfort Panels, including TP1200 and TP1500 color touch models
- Simatic IPC industrial PCs, including IPC277, IPC477 and IPC677 models
- Sinamics G120 and S120 drives for vector and servo motion-control duties
- Scalance S615 managed switches with built-in firewalls for secure yet fast, prioritized packet traffic.

One feature of the Scalance switch that especially impressed us was its high-speed, highly deterministic isochronous real-time (IRT) Profinet with data-exchange cycles ranging from a few hundred microseconds up to a few milliseconds. With this protocol, the switch divides the bandwidth into two intervals: one is used for ultra-fast, deterministic data transfer; the other is used for standard Ethernet data that are not time-essential. This is extremely useful in robot applications, where motion control is critical. Our new plant needed this kind of flexibility that's native to the Scalance switch.

All of the Siemens components are part of the Siemens Totally Integration Automation (TIA) portfolio. Modularly designed, many are self-configurable, which makes them effectively plug-and-play. Many have built-in web servers for remote diagnostics. All are programmable via the user-friendly, drag-and-drop capabilities of the Siemens TIA Portal. The TIA Portal is a common software engineering framework that can save as much as 30% or more of programming time, especially given its libraries of proven code.

EXTRAORDINARY MIGRATION SUPPORT

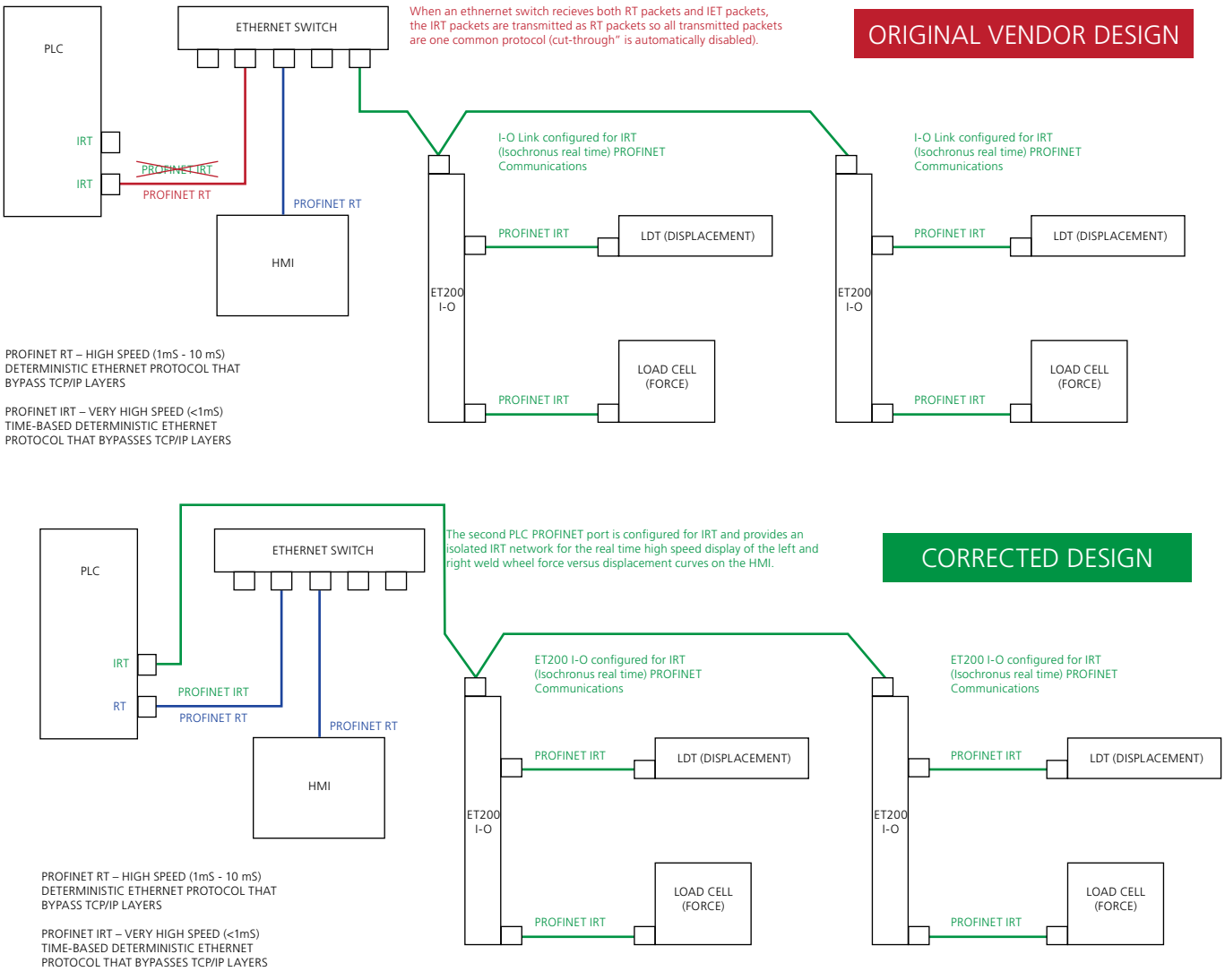
In converting the code from the previous automation supplier to what can be used in the Siemens TIA components, we found the support by Siemens and C&E Sales to be unheard of in this day and age. We took a Siemens class specifically for migrating existing code, again taught by former employees of that supplier. The instructors know both programming environments, so they could guide us in every conversion requirement. Even more, Siemens was willing to help our machine builders with their programming issues, too.

One machine builder had spent the better part of a week trying to get IRT Profinet to work with a two-port Simatic S7-1500 PLC model. When I found out his problem, I called my contact at C&E Sales, as I didn't know anything about isochronous real-time communications. He explained it to me in just a few minutes and how to use one PLC port for the IRT and the other for regular Profinet. I shared that with the machine builder and it worked. It took just 10 minutes. I've never seen anyone happier.

THE NEED FOR SPEED

The application was high-speed data collection of dual force versus displacement data

Network for real time diplay of left & right weld wheels force vs. displacement curves



LET'S GET ISOCHRONOUS

Figure 3: The combination of very high speed, low latency and a high degree of determinism with Profinet IRT allows the PLC to perform very high-speed data collection that is not possible using Ethernet protocols developed for the office environment.

sets on the left and right resistance weld wheels of a reservoir tube seam welder. The seam welder welds a base cup to a reservoir tube to close one end of the tube for automotive suspension damper products.

The machine builder had finished design and construction of a reservoir tube seam welder. The machine design included two resistance weld wheels with each utilizing high-speed force and distance measurement

transducers on Siemens ET 200 I/O modules communicating to the Siemens S7-1500 PLC through a Siemens Ethernet switch. The goal was to capture and display an X-Y scatterplot of weld wheel force versus displacement data sets for the two resistance weld wheels in the PLC and display the data on the Siemens TP1200 HMI. The controls engineer configured the high-speed analog I/O modules connected to the load cells and the position transducers for isochronous-real-time (IRT) communications.

Profinet RT is high-speed Ethernet communications with a typical latency of 1 ms to 10 ms and is used for communication between the PLC and the HMI and general analog and digital I/O. Profinet IRT is very high-speed Ethernet communications with a latency of 1 ms or less with 250 microseconds possible. The combination of very high speed, low latency and a high degree of determinism with Profinet IRT allows the PLC to perform very high-speed data collection that is not possible using Ethernet protocols developed for the office environment (Figure 3).

THE BWI 4.0 JOURNEY

The new BWI Group plant opened with the most modern and cost-effective automation and control systems of all its plants worldwide. Not only were Siemens component and software prices much lower than those of the previous supplier, but features such as the PLC's integrated safety eliminated the need for adding safety relays throughout the plant.

We saved about 10% of our overall automation and control costs by using the safety-integrated Simatic PLCs. That alone helped us avoid capital investments that we'd otherwise have to spend to ensure the safety of our production floor.

BWI adopts new and emerging technologies based on several factors:

- cost savings: lower investment in capital equipment
- additional features: reduce equipment downtime, improve efficiency or reduce maintenance costs
- connectivity: increased integration and communications that simplifies collecting data and turning it into information.

Integrating safety and control simplifies the control-system design and is less expensive in most cases. Safety programming and control programming are performed within one common integrated development environment. Most importantly integrated safety and control has been proven to be robust, reliable and secure from unauthorized modifications.

Of course, we appreciated how the size of the cost savings on Siemens components and software, plus the cost avoidance their features offer, helped us to meet the 25% cost-reduction goal. We also valued the

support from both Siemens and its distributor C&E Sales every step of the way.

I just can't speak highly enough of the support we get. For example, I wanted to implement the message-queuing-telemetry-transport (MQTT) protocol on the Simatic PLCs. I went to the Siemens website, quickly found a white paper on the topic and then was asked if I wanted to download the code, which I did. This saved me at least 80 hours and probably more like 160 hours had I coded it myself.

MQTT is a publisher/subscriber protocol used within the edge-computing portion of Industry 4.0 to gather data from various remote processes not requiring high rates of data transfer, such as the temperature of a 350-gallon fluid tank. Since the temperature of the tank changes very slowly, capturing the temperature 1,000 times a second is not necessary, and once a minute is sufficient. Using a transducer with Wi-Fi and MQTT capabilities allows us to capture the necessary data wirelessly from a remote tank without long cable runs.

NEW DIRECTIONS

This experience was different from the former supplier's wanting a $200,000 contract to access the documentation needed to resolve PLC support issues. Another time, I was headed to our Poland factory where our machine builder was having problems getting IRT data from Siemens S7-1500 PLCs to display an X-Y scatterplot on the Siemens HMI TP1200.

Before takeoff, I rang up my Siemens distributor contact, who pointed me to a Siemens white paper, plus links to the TIA Portal and sample code. I forwarded those to our controls engineer in Poland. By the time I arrived many hours later, they had the configuration done except for some communication issues, which we resolved quickly with another call back to our Siemens distributor. We solved our problem with two quick phone calls, one from 4,755 miles away, and both at no cost.

DIRECT SUPPORT WORLDWIDE

Siemens and its distributors stand 100% behind their products before, during and after the sale. And they get back to us in minutes or hours, whereas our previous supplier would take days or weeks, if ever.

Moving forward, we're counting on the Siemens partnership to help us to realize our BWI 4.0 vision with all new equipment standardizing on Siemens components and software, while using the TIA Portal as a common engineering framework. We're already planning on implementing that policy in the Mexico plant, and we expect the standardization to help reduce parts inventory costs.

BWI is taking advantage of the variety of Siemens PLC processors to fit the best

solution to the automation application. For example, using a safety PLC processor on small or simple standalone production machines eliminates one safety relay and provides some savings, but the most savings are realized on complex multi-station power and free pallet production lines, where 30 to 50 safety relays can be replaced by one safety PLC processor.

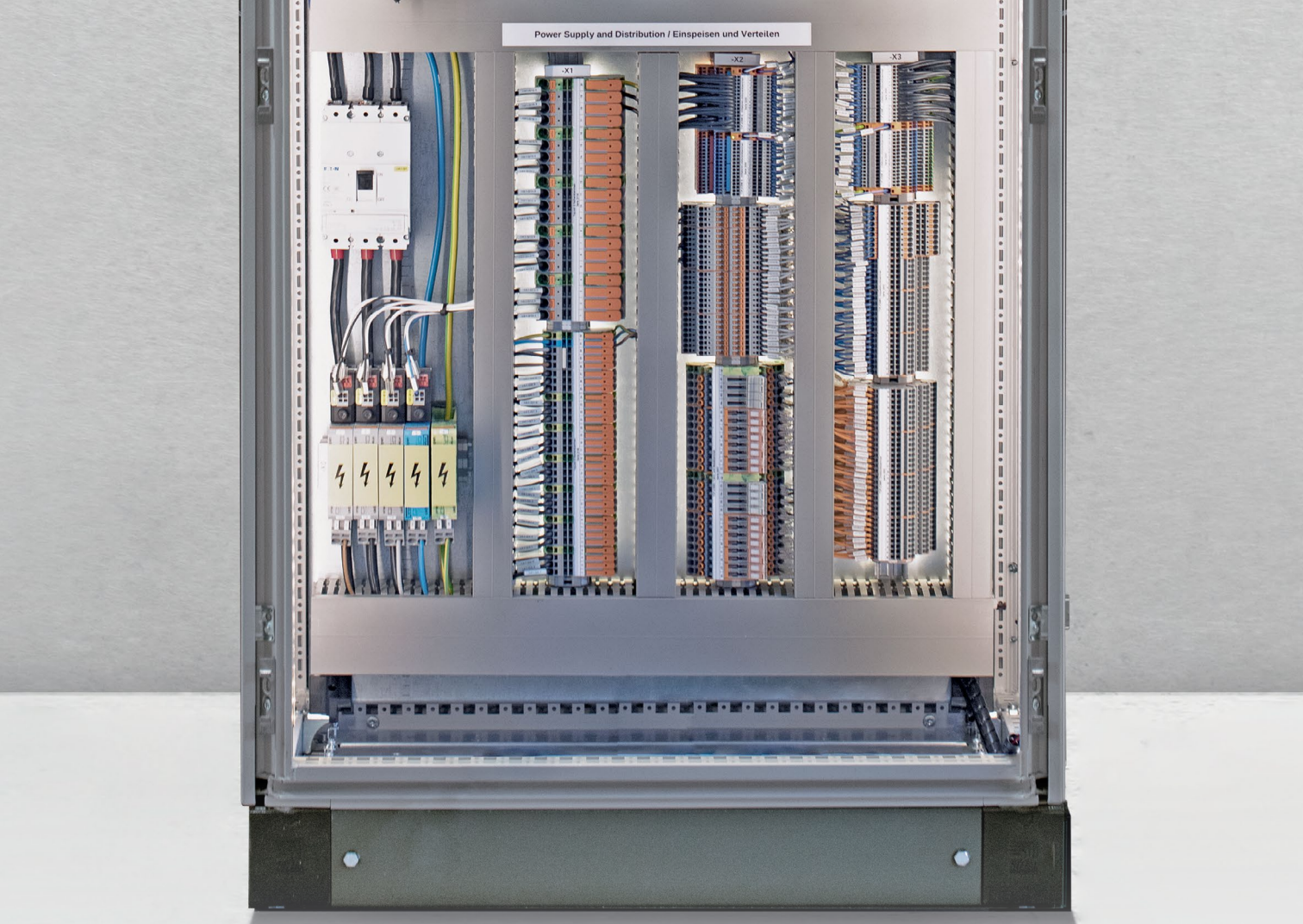
ROADMAP TO THE CLOUD

Eventually, the BWI 4.0 team expects to interconnect the company's plants and tech centers worldwide to take advantage of digital-twin concepts, advanced analytics using artificial intelligence and machine learning, among other technologies.

The team knows a cloud approach is the best, most cost-effective way to achieve these capabilities, so they are seriously evaluating the cloud-based Siemens MindSphere IoT operating system as a platform of choice. While we haven't ruled out other cloud platforms at this point, we are giving serious weight in our selection criteria to the extraordinary support we've come to expect from Siemens and its long-established, global network of highly qualified distributors such as C&E Sales.

The fact is, we don't think their support was a one-time act to win our business; we think it's truly how they do business by putting the customer first. It's clearly part of their culture.

F.W.B. (Bill) Taylor III is controls engineering supervisor at BWI Group. He is based at the company's Dayton Technical Center in Dayton, Ohio, but supervises machine control system designs for all of North America. He earned a BSEET degree from the University of Tennessee in 1980 and MSECT from Indiana State University in 2004. His career spans more than 30 years working with industrial automation in multiple industries including food processing, automotive subassemblies and appliance manufacturing. He is familiar with many industrial processes: parts assembly, laser, MIG and TIG welding, fluid dispensing, precision machining and component performance testing. Equipment ranges go from small standalone lean machines to large power and free palletized assembly lines. His current role includes supervising the machine control system designs for all new equipment destined for the Greenfield, Indiana, facility and the existing Chihuahua, Mexico, plant. Taylor leads teams for implementing traceability, total predictive maintenance (TPM), strategic planning and BWI 4.0 (Industry 4.0), concentrating on the digitalization of production throughput. Contact him at fwb.taylor@bwigroup.com.



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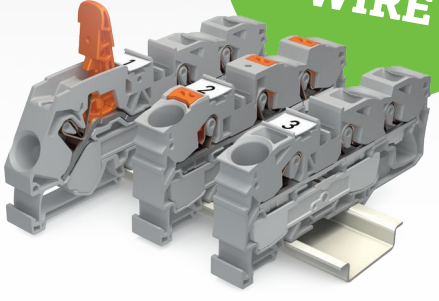

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WAGO

PLC-ready for today, tomorrow and the future

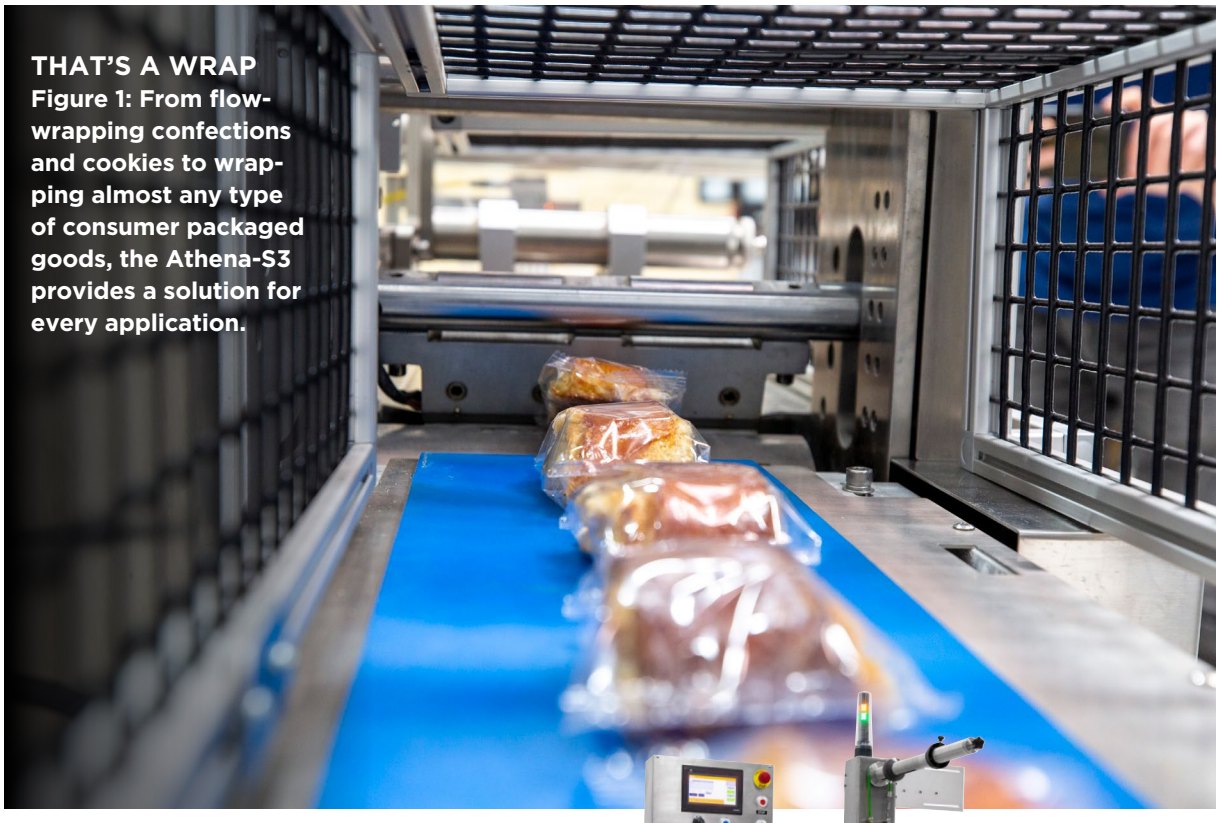
Packaging industry partners utilize scalable platform to develop modular flow wrapping machine fit for the future

By Herbert Youssefian, Packaging Made Easy

Two companies that have a strong presence in the packaging industry, EIS Automation (www.eisautomation.com) in Las Vegas, Nevada, and Packaging Made Easy (www.packagingmadeeasy.net) in Chino, California, partnered to engineer a modular horizontal flow wrapping machine that adds value to packaging operations while being well-positioned to provide manufacturing advantages in the future.

Omron (automation.omron.com/en/us/) became involved in the development process through an existing partnership with EIS Automation. Based on the project goals, Omron engineers worked side-by-side with both companies to incorporate several solutions that would give end users more control over their machines. Along with a customized human-machine-interface (HMI) screen that promotes maximum flexibility and ease of operability, Omron also provided the technology behind an initiative to let end users seamlessly add functionality to the core machine as operations change in response to market demands.

Packaging Made Easy, which serves the pharmaceutical, medical-device, food-and-beverage, cosmetics and confectionary and many other industries, has seen success with the launch of the Athena-S3, a fit-for-the-future, modular flow wrapping machine (Figure 1). The company is also promoting a multi-step plan for improving an entire packaging process in which new functionality can be seamlessly added without replacing the core machine (Figure 2). This process includes, among other things:



THAT'S A WRAP
Figure 1: From flow-wrapping confections and cookies to wrapping almost any type of consumer packaged goods, the Athena-S3 provides a solution for every application.

- incorporating automation on the feeding side
- adding a collaborative robot for casing at the end of the line
- a complete, end-to-end traceability system
- automated quality control subsystems.

MULTI-STEP PLAN
Figure 2: Designed to be modular, the Athena-S3 promotes a multi-step approach for improving the entire packaging process.

BACKGROUND

EIS Automation, an automated packaging system integrator that covers a wide variety of packaging automation needs, entered into a strategic partnership with Packaging Made Easy, an OEM specializing in horizontal flow wrappers and other packaging process innovations, to address an unfulfilled need in the market (Figure 3). The two companies began working together to develop a scalable, modular flow wrapping machine that would stand the test of time and be fully adaptable to changes based on market demands.

During their own market research, the companies were able to pinpoint a disconnect between how most processing and packaging companies envisioned a future-ready machine versus what features were actually available on machines ready for purchase. They were often contending with end users who would sometimes procure a machine based on price and find that it would not meet their preconceived needs for functionality.

At the same time, those machines would only work for a short period of time or would require frequent repairs that were difficult to accomplish.

Finally, with a great many of those machines being shipped from out-of-pocket outlets or even from a refurbished source, finding local support from the OEM also proved to be difficult. Tackling these challenges head-on, EIS Automation and Packaging Made Easy developed the Athena-S3 Horizontal Flow Wrapper,

SAGE BY THE BUNDLE
Figure 3: Product is transferred from the conveyor into the plow fold section where the film wraps a bundle of sage.

a user-friendly machine requiring little to no training and for which support would be readily available across North America.

The advantage of a solid service-and-support network is processors and packagers can be tempted by a low price. Unfortunately, initial savings are often outweighed by the costs of maintaining and repairing machines in the future. When a machine isn't serviceable by an OEM, it may mean that it was acquired through a third party and not registered to the procuring company. A myriad of problems can follow, ranging from difficulty obtaining spare parts to confusion over who is responsible for general and emergency service and support.

On top of these mounting issues, price-effective machines can be island solutions, or static machines that are neither scalable nor modular in nature. These types of machines make it difficult to integrate additional automation modules, such as robotics and machine vision, after purchase. EIS Automation and Pack-

Both companies have access to an additional layer of product support and application assistance.

aging Made Easy maintain the design and build of the Athena-S3 and have a solid network of authorized service and support professionals located throughout regional markets. And with their flow wrapping machine being automated by Omron, both companies have access to an additional layer of product support and application assistance through Omron support specialists.

CHALLENGE

Prior to working with Omron, Packaging Made Easy sourced machines from various OEMs.

These machines functioned well and performed as the OEM intended, but they usually required a significant amount of engineering hours for modifying mechanical and electrical components to satisfy the goal of offering their end users a scalable and modular machine that could readily adapt to future market changes. This lack of control over the guts of the received machines made it much more difficult to customize solutions that fully covered their desired offering.

Packaging Made Easy also found that the received machines were often equipped with automation technologies from multiple vendors, which made control of the entire machine more challenging.

For example, at times, certain control technologies would have trouble communicating with a different brand of servo motor. And oftentimes other controllers were limited in their capabilities to control other manufacturers' components.

Most aspects of the original application would need improvements, including the motion, controls and HMI integration. Due to these challenges, Packaging Made Easy started looking for a new hardware solution, as well as a new platform that would provide easy troubleshooting and simple remote connectivity. It challenged EIS Automation to help the company design and build a custom machine with integrated control and components that would work seamlessly together without incurring a high number of engineering hours.

SOLUTION

The partners chose to power their machines with the Omron NX1P2 programmable logic controller (PLC). It runs on EtherCAT and is compliant to IEC 61131-3, a vendor-indepen-

dent, programming-language standard for industrial automation.

"The NX1P2 model we selected has coordinated motion capability for up to four servo axes over EtherCAT, which was a great fit for the three-axis requirement of the FlowWrapper," says Josh Watson, managing member EIS Automation.

Coupled with the NX1P2, the partners chose the award-winning 1S series of servos for motion control, the NA Series HMI for quick activation of add-on functionalities, and the NX-TS I/O for bag sealing, according to ASTM standards.

"Our plan is to export the Athena FlowWrap in the near future, and we needed a controls component provider that offers a standardized component platform with a global presence and support," says Watson. "Serviceability and using components from one manufacturer for easy integration without compatibility issues was a very important decision-making factor, as well."

The Omron 1S Series is a servo system designed to optimize the full cycle throughout machine design, installation, commissioning and maintenance (Figure 4). Offering a high-resolution multi-turn encoder without battery backup, a built-in safety network and improved loop control, the 1S supports higher levels of machine productivity with exceptional accuracy.

OPTIMIZE THE FULL CYCLE
Figure 4: The servo system assures precise positioning, smooth acceleration and deceleration for perfectly sealed packs.

Features include:

- power range from 100 W to 3 kW, 100/200/400 V
- 23-bit high-resolution encoder
- 350% momentary maximum torque (200 V, 750 W max)
- fast, secure screw-less push-in control I/O connector and brake interlock connector
- pluggable connectors in all connectors for easy pre-wiring and system maintenance
- direct wiring of I/O signals to eliminate the need for terminal block units.

"We investigated two other motion control platforms but eventually decided to standardize on the Omron platform due to the wide offering of controls products and expandability with our modular design approach," explains Watson.

Programming in Sysmac Studio, the advanced automation platform from Omron,

MORE, MORE, MORE
Figure 5: This add-on, end-of-line modular solution using the Omron collaborative robot provides automated pick-and-place of primary packaging into cases for distribution.

proved to be an intuitive and efficient way to then communicate with the PLC, which then sends packets of data to the individual components on the EtherCAT network. Both EIS Automation and Packaging Made Easy saved time designing the initial architecture of the robust network that makes the Athena-S3 Horizontal Flow Wrapper scalable for the future.

"From the beginning, our goal was to design a scalable platform that has a modular approach at its core," explains Watson. "This will allow customers to grow the platform with their operation. Starting out with just the FlowWrap, once volume increases, we can easily add an end-of-line pick-and-place solution, machine-vision quality control or ID and traceability (Figure 5)."

Other special features include custom HMI screens with intuitive navigation and embedded troubleshooting, an easy-to-activate energy savings mode, automatic bag size calculation functionality and a remote servicing module that allows for quick support via VPN whenever necessary.

"The remote service module is integrated into every machine as a standard," explains Watson. "The main reasons are the ability to help customers to troubleshoot remotely by logging directly into the control system of the machine. The second important aspect

is the ability to download new software revisions/updates to the machine remotely. In order for us to do this the customer doesn't need a laptop and/or any software; just plug the network cable into any network port with Internet connection in the plant, and we will be able to help via secure VPN tunnel."

Omron engineers worked with both partners to make this machine a great fit for processing and packaging companies that are looking toward tomorrow.

RESULTS

The Athena-S3 Horizontal Flow Wrapper has already seen plenty of success with its recent launch into the market. Packaging Made Easy has recorded a 124% increase in sales and expects demand to continue to grow with processing and packaging companies' increased investment in automation. Omron controls, motion and industrial components can be recognized in every Athena-S3 that comes out of the production facility, thanks to its ability to enable a wide range of features that add value for manufacturers in the packaging sector looking to find machines that can be modified as the market changes.

COBOT-TENDED
Figure 6: Integrated at end-of-line, the Omron collaborative robot places packs onto another conveyor for casing, automating the entire packaging process.

Packaging Made Easy is also promoting its multi-step plan for improving an entire packaging process, which involves providing the ability to seamlessly add new functionalities without replacing the core machine. This involves the development of an end-of-line modular solution using the Omron series collaborative robot for automated pick-and-place of secondary packaging (Figure 6). This module will also be scalable, allowing end users to incorporate add-ons as demands shift within the industry, also making it truly fit for the future.

Herbert Youssefian is president of Packaging Made Easy (www.packagingmadeeasy.net). Contact him at sales@packaging-madeeasy.net.

Controller upgrade modernizes American Castings' molding line with minimal downtime

Replacement control system with legacy I/O allows company to avoid weeks-long production outage

By Darryl MacKay and Roger Gibson, American Castings

American Castings (www.american-castings.com) supplies large metal components to some of the world's heavy equipment makers. The Pryor, Oklahoma-based company makes axles, frames, suspensions and other components that weigh up to 3,500 lb and are used in mining, farming and oilfield job sites (Figure 1).

The foundry where American Castings (www.controldesign.com/americancastings) makes its heavy-duty metal components has been in operation for more than 35 years. Recently, the control system on one of the foundry's main molding lines was showing its age, and the company decided it was time for an upgrade.

This presented a major challenge. Migrating the line's control system and extensive I/O to new technologies would require weeks of downtime, something the company's production schedule couldn't afford.

IRON GIANT
Figure 1: American Castings supplies axles, frames, suspensions and other components that weigh up to 3,500 lb.

Then, one day, a routine sales visit led to a solution that would allow American Castings to upgrade the line's controller while avoiding extensive downtime.

OBSOLETE AND DISRUPTIVE TECHNOLOGY

The control system at issue was on the automated no-bake molding line, one of two production lines in the foundry.

The no-bake line consists of a series of conveyors where sand molds are created, and molten metal is poured into them (Figure 2). Once metal solidifies, castings are shaken to remove the sand (mold). Throughout the line, transfer cars are used to move the molds from one conveyor to another.

The decades-old controller on the line was obsolete and causing production disruptions. In particular, the controller was experiencing slow scan times, which is how long it takes the controller to take in, read and react to information.

If a conveyor was moving and a limit switch told it to stop, it could take an extra half second to one second to stop. When this happened, the metal part could move out into the way of the transfer car, and then we have a crash.

The crashes were not catastrophic, but they occurred multiple times a day and took a toll on productivity.

CONVEYANCE
Figure 2: The no-bake line consists of a series of conveyors where sand molds are created, and molten metal is poured into them.

We're dealing with parts that are several feet long and weigh hundreds of pounds. You don't just pick it up and put it back in place.

Not only was the controller obsolete, but so was the 1980s-era computer technology used to support it.

If something happened on the line, we had to use a computer to troubleshoot the PLC's ladder logic. But the control technology was so old that we had trouble finding a computer that was slow and dumb enough to talk the same language.

It was clear the no-bake line needed to be modernized with the latest control technologies. The question was how to do it. The system had 10 remote I/O racks and about 1,100 I/O points. Replacing the controller and all the I/O would bring down production for four to six weeks. The company couldn't afford a stoppage that long, given its high production levels.

A HOME-RUN SOLUTION

We chose to migrate the no-bake line's legacy control system to an Allen-Bradley ControlLogix controller from Rockwell Automation. The modern controller offered significantly greater performance and capacity than the legacy PLC to resolve the slow scan times on the line. It also offered greater data availability. And it would eliminate the need for ancient computer technology to troubleshoot issues.

As far as how this new controller could be implemented with a minimal impact on downtime, a serendipitous encounter helped American Castings find an ideal approach.

A representative from Rexel, an automation distributor, just happened to be at the foundry when the topic of the control system upgrade came up. The representative mentioned the EtherNet/IP to Square D Remote I/O Gateway from ProSoft, an Encompass Product Partner in the Rockwell Automation PartnerNetwork program. The gateway would allow the new ControlLogix controller to talk to the legacy I/O.

The gateway would only be a fraction of the cost of replacing the line's I/O racks and rewiring all the I/O points. More importantly, the time savings from avoiding all that work would allow the control-system upgrade to occur with minimal downtime.

Before implementing the gateway on the no-bake line, our department, which also includes Jerrod Estes and Chandler Beck, decided to first try the solution in a similar upgrade for the foundry's environmental system. The system, which runs all the roof ventilation for the 433,000-sq-ft facility, used the same proprietary control system and I/O as the no-bake line.

In that pilot project, not only did the gateway allow American Castings to retain the environmental system's legacy I/O, it also improved connectivity to the different environmental units across the facility. Instead of walking across the massive facility just to confirm that fans are running, or to turn air units on and off, workers could now do those activities from a central operator station.

The new system ran about one year without a single iota of a problem. We found we had a home run. We were ready to bring this to the no-bake line.

NO GROWING PAINS

With the new control system now in use, the no-bake line is achieving scan times that are up to five times faster than the legacy controller (Figure 3). This has improved machine reaction times on the line and tightened conveyor movements, putting an end to crashes resulting from slow scan times.

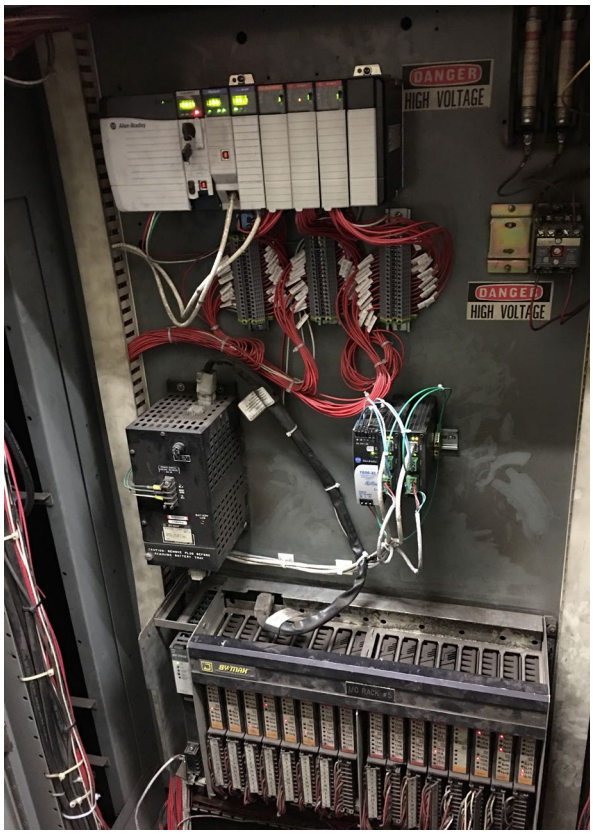
The new control system and its connectivity to devices on the line has also made operational data more accessible. Now, production managers can follow each component's journey through production, as well as track overall line performance and downtime.

We expect the new control system will eventually help us increase production from about 30 or 40 molds per day to 60 molds per day.

The ProSoft gateway allowed the upgrade to occur at a much lower cost and with minimal downtime compared to replacing the legacy I/O.

American Castings saved more than $100,000 in wiring and installation costs, alone, by retaining the existing I/O on the no-bake line. And not having to shut down the line for up to six weeks saved the company hundreds of thousands of dollars more.

Certainly, not having to rewire more than 1,000 I/O points helped reduce downtime



FASTER SCAN TIMES

Figure 3: With the new control system now in use, the no-bake line is achieving scan times that are up to five times faster than the legacy controller.

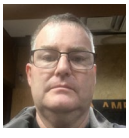
for the project. But our team was also able to run the new control system in supervisory mode to commission, test and tweak it while production continued running using the legacy system. We worked with ProSoft technical support to workout a few minor bugs related to fault handling of scans that caused a few minor headaches but were quickly taken care of.

All told, instead of being down for four to six weeks, the upgrade only brought down the line for a matter of hours.

> Not only was the controller obsolete, but so was the 1980s-era computer technology used to support it.

Typically, once you start a control system conversion, you're committed until it's complete. This approach allowed us have the two systems running essentially in parallel. We could go in, test the new system and review the results without taking production down for an extended period.

Currently, two of the no-bake line legacy I/O remote racks have been replaced with Rockwell Automation remote I/O with no additional loss of production. The ProSoft gateway continues to allow communication to the remaining legacy I/O racks. There are plans to replace the remaining legacy I/O on the no-bake line as the production schedule allows. With the ProSoft gateway in place, American Castings will be able to migrate one module or rack at a time based on what works best for the company and its production schedule with little or no downtime to the line.



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