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PRODUCT SELECTION AND APPLIED TECHNOLOGY HANDBOOK 2019

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Publisher's Note

by Kurt Belisle

Publisher, *Automation World*

Step Back Before Moving Ahead with Your Digital Future

New, advanced automation technologies are constantly emerging in the Industrial Internet of Things (IIoT), Industry 4.0, and smart manufacturing space. And while the emergence of these new capabilities can be exciting, it can be easy to lose sight of what drove you to investigate them in the first place.

So, as you begin adopting digital technologies as a means of staying competitive in the years ahead, don't lose sight of fundamental business practices as you move towards your more connected, digital future.

To ground yourself, first take a few steps back and look at the whole picture. Focus first on the specific problems you need to solve, realizing there will likely be numerous ways to solve them. The array of options presented by new automation technologies underscore the importance of having a plan that identifies your goals from the beginning. Though those goals will likely change as you move forward, having those initial plans clearly identified is a critical first step. When you don't have such a plan, it's harder to identify the technologies that can help you the most and that will be flexible and scalable enough to be of use in the long term.

This handbook is designed to provide you with an array of practical ideas—in line with core business fundamentals—to help you determine if you have the proper foundational technologies in place before moving forward. The articles in this handbook will also illuminate a number of potential approaches to your digital future. From assessing your current PLC and HMI tehnologies to preparing for necessary updates, incorporating data analytics into your processes, and investigating critical industrial network considerations, you will find in these pages a wealth of real-world information from experts in the field.

As you take what are likely some of your early, yet important, steps towards your company's digital transformation, make sure to repeatedly assess your current situation as it develops to ensure that the choices you are making are the right ones at the right time for your operations. And remember to keep taking those few steps back to maintain a proper view of your entire operations to support the decisions you'll continually have to make. After all, since the promise of the digital future is to connect everything for a better view of your business, decisions can't be made by looking at your operations as separate functions. The digital future is all about eliminating these siloes of information and connecting them not just to improve production, but to introduce new ideas and opportunities for your company that do not currently exist.

Don't Wait to Migrate Your Aging PLCs and HMIs

As systems, interfaces, and technology age, the chance of something going wrong rises and the chance of manufacturer support gets lower. Modernization and migration of these items is key to making sure everything operates smoother.

*By **Jack Fillenwarth,** automation engineer, Panacea, www.panaceatech.com*

The need to update legacy systems becomes more urgent as automation hardware increases in complexity and regulations become stricter and more defined. However, migrations can be costly and time-consuming, so many of us would rather put them off until next year...or maybe the year after that to keep processes up and running. After all, the increased uptime leads to more revenue, right?

Advancements in functionality have made the case for accelerating the migration timeline. On a recent project, there was a need to reset passwords when operators were locked out. But, because the passwords were hardcoded, the legacy system required me to access the programmable logic controller (PLC) remotely, since there was no other way to change them. This practice poses security risks and impacts the regulatory compliance of the system. A modern device could be integrated with the site domain, allowing users to authenticate into the human-machine interface (HMI) using their domain credentials. Password changes would now be governed by company policies, increasing security and inheriting enterprise password requirements. More importantly, HMI actions would now be attributable to individual users, a major regulatory requirement in many industries.

The importance of secure and updated communication protocols is not limited to HMIs. On another project, we were tasked with upgrading a legacy PLC. The only copy of the code was on the live processor, which was equipped with a DH-485 port. Simply connecting to this processor turned out to be comically complicated. First, we tried a DH-485 to serial converter, but we couldn't find a computer with an old enough operating system (OS) for the driver to work. Then, we tried an adapter that went straight from DH-485 to USB, but after many attempts, we determined the cable was defective. It took multiple trips to the distributor looking for something that would talk to this controller, which was the sole device controlling a critical site utility function.

Eventually, we tracked down a PC-card converter, a special proprietary cable to use with it, and a computer with the exact Windows XP service pack we needed and straightened out the licensing to use the software and drivers. Finally, we were able to upload the code, though with a significant chunk of our schedule spent just trying to communicate to the PLC.

The point of this is not just to add to the war stories told by others, but to serve as an example of why modernization is important and grows in importance as systems age.

Also, manufacturer support doesn’t last forever. The longer an older device sits in its panel untouched, the less likely help will be available when something goes wrong. And eventually, something will go wrong.

This process doesn’t have to be scary. Carefully considering new power and I/O requirements, hardware sizing, and required testing can help prevent headaches during the migration process. Often, tools within automation software packages carry out most of the code migration for you, and a migration gives you the chance to implement other changes to your code that would be too extensive for a typical downtime period. So, consider moving your migration project to the top of your to-do list. It might pay off sooner than you think.

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Understanding IIoT Communications

Though the cloud and Big Data analytics are important components of the Industrial Internet of Things, don't forget to start with the necessary communications layer and work your way up from there.

*By **Michael Bachelor,** president, Bachelor Controls, www.bachelorcontrols.com*

I have had several discussions with various vendors, distributors, and other integrators regarding Industrial Internet of Things (IIoT) offering. I have read articles regarding whether or not IIoT is really coming. I am not sure if we're all on the same page regarding what IIoT is and the communications demands therein.

If you believe we already have all the devices in our control systems, and IIoT is getting everything on Ethernet, and adding the cloud with Big Data analytics and dashboards, then you're focusing on analytics. That's fine, but that's not IIoT. That's advancing analytics that have been around for a while, which is a good place to be. But that is not necessarily IIoT.

The cloud and Big Data analytics are important components of IIoT solutions and smart manufacturing. So, it is indeed an advancement to get there. However, you cannot solve an IIoT offering with software and the cloud alone any more than you can a control system. A control system needs control hardware with a control communications layer along with the equipment and devices. Then software can contribute. Likewise, an IIoT offering is about the "things" first.

Look up the Purdue Reference Model (PRM) used in ISA-95, and look at Level 0 and Level 1. That's where we start an IIoT offering just like a control system, even if we know we are also implementing Level 3 solutions and integrating top to bottom. I don't think this idea is foreign to most reading this. However, there is a gap between the Level 0 and 1 control system and the Level 0 and 1 IIoT offering. I have mentioned this before, but I want to bring a focus to it now.

As control system integrators, we typically consider that we have the device-level communications (PRM Levels 0 and 1) covered. If new devices come into the system, we solve any communications hurdle and bring it into our system. Not all IIoT offering will come back to the control system, though. For instance, a safety application using a camera should be integrated with control. Calculating inventory levels that a batching system uses as source raw material will be integrated to some degree. Safety inspections might not be. Security might not be. Accountability systems might not be.

Sensors might or might not be connected with control. If a sensor contributes to analytics but is not a tangible contribution to the control system, then it might just be clutter for the control system.

If a sensor is remote, it might not make sense to add it to the control system. It might not make sense to connect drones to the control system. It might not make sense to tie trucks in the supply chain to the control system.

Communications with enterprise resource planning (ERP) systems, databases, cloud solutions, Big Data, and other various software solutions are important. Communications with control systems and integrating with enterprise software is important. These are covered well. This does leave a gap, however. What about the Level 0 and 1 IIoT offerings that extend control solutions or add solutions not even related to control?

This gap between control systems and IIoT offerings is met by a gap in communications as well. We know how to get our systems on Ethernet, hardwired or via Wi-Fi. We know how to convert or bridge the gap to many different legacy plant floor networks and protocols of the past. What is new is thinking about things outside of that domain. We might have to think about communications such as cellular, redundant cellular, RF and low-power RF, NFC, LoRaWAN, BLE (Bluetooth low energy), ZigBee, Thread (IPv6), CAN bus, long-range Wi-Fi, specialized new IoT sensor modems, and more. This is a communications integration project by itself within an IIoT solution, and probably a proof-of-concept hurdle for many customers who are forward-thinking in this way already.

Furthermore, once you can reach out and touch a thing, you will need to be able to speak its language as well. That might or might not happen via a typical hardware module or OPC driver that control system integrators are used to.

If engaging IIoT, engage it at the tangible hardware level first. IIoT is a bit like a control system or a plant floor analytics solution, except with more parts and pieces that could come in from a broader area and a larger context of business factors than operations. We have more things in more places to talk to over various networks that speak various hardware languages we are not necessarily used to. Solve problems for IIoT at ground level, going back to the days when communications were half of the battle. Then build up to the cloud from there where warranted.

7 Considerations for Mechanical and Automation Migrations

To help you get through the pressures that your team will undoubtedly face during a migration, consider these important steps to prepare.

*By **Heather Johnson**, division manager, Interstates Control Systems, www.interstates.com*

Making major mechanical and automation upgrades can put a lot of pressure on a facility and its team. As with most projects, challenges will be experienced. Here are the top seven things to consider during the migration process:

1. Ensure you have the right people available in the right area of the plant during the checkout/startup phase. This includes site personnel, representatives from vendors, and/or system integrators. Everyone will be working within a budget and there will be a limited number of people who know the system. Be sure to keep the schedule in front of everyone and plan accordingly.

2. During the commissioning phase, expect things to not go perfect. Make sure to involve people who understand how the system needs to run and, if doing a retrofit, how it ran previously. Working as a team is crucial to successfully make adjustments to the programming or mechanical when needed.

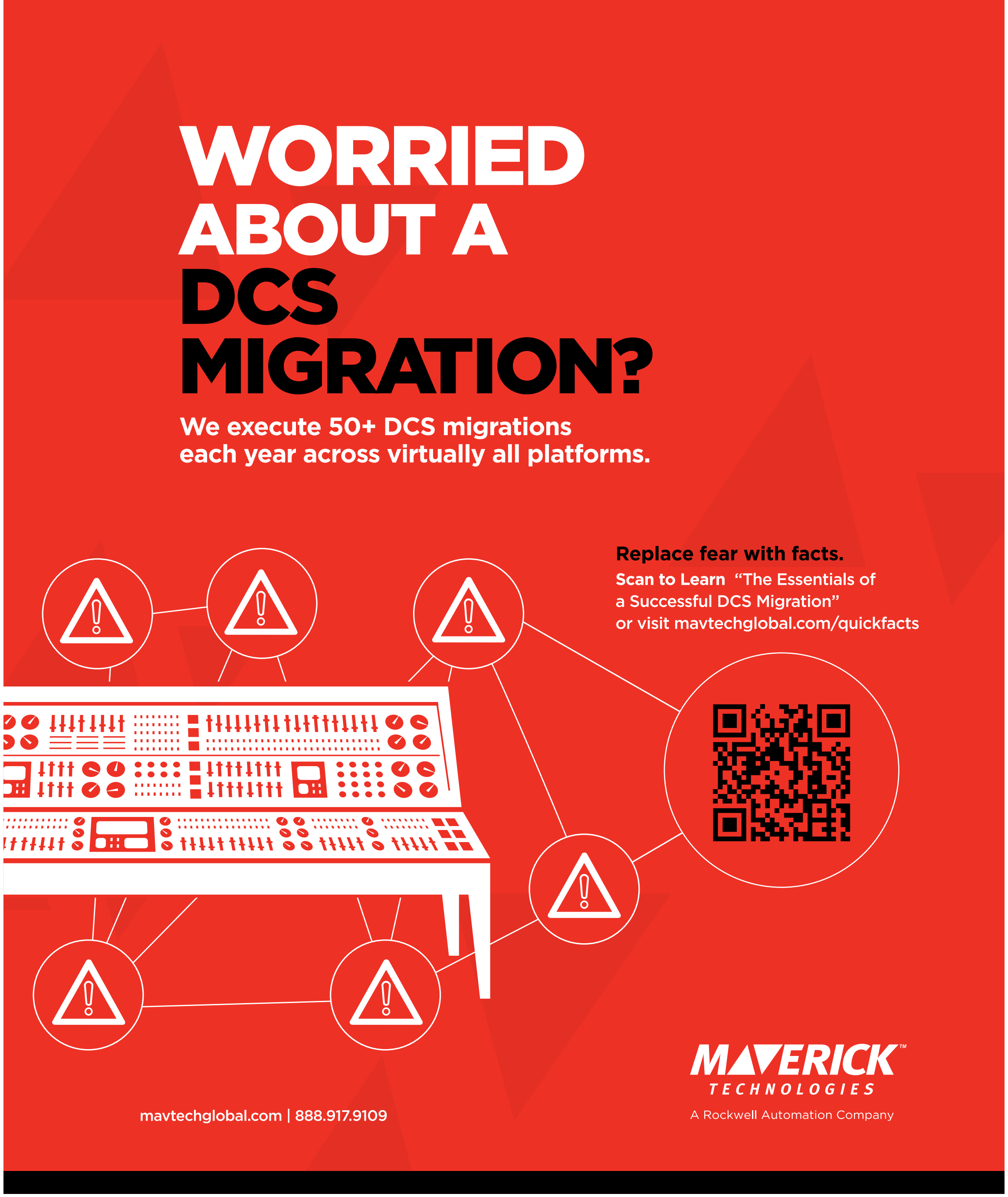
3. Establish a chain of command. Assign a point person who has the final say on decisions during checkout/startup.

4. Limit the number of changes leading up to and during checkout/startup. If a change is made at this time, it should be critical to the success of the project.

5. Make time for system training before and after the shutdown. Ideally, hands-on training will be implemented with the system through a user acceptance test prior to the shutdown. The number of changes applied to the control system will determine how much time is needed for the system integrator to stay onsite and work with operations and maintenance in understanding the system.

6. Consider scheduling a follow-up trip several weeks or a month post-startup to fine-tune how the system is running. This time can also be used for more detailed training with your controls maintenance team to help them better understand how to effectively troubleshoot the new system.

7. An operator manual is a standard expectation with a control system. Another option to consider that might be more effective for future use would be short training videos made on frequently needed topics. It is common to use websites such as YouTube to find a visual on how to do something rather than reading written steps.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6 Steps to Supporting an Automation System

When you find yourself trying to get a broken system up and running again, going through the troubleshooting process systematically can help. Here's a six-step process.

*By **Ed Miller,** engineer, Avanceon, www.avanceon.com*

Every automation system eventually develops a situation requiring advanced engineering support. This type of break-fix support could be due to any number of causes—power outages, server maintenance, operator error, etc. But no matter what the root issue turns out to be, sooner or later, every system will need it. And that's why it's equally sure that, here at Avanceon, all our engineers will at some point find themselves helping to support customers to keep their manufacturing processes running.

Troubleshooting, like coding, is a unique and special set of skills, and each person might have a slightly different approach to resolving an issue. When I find myself in a break-fix situation, I tend to follow a regular procedure to try not only to fix the problem but also determine the root cause of the issue.

STEP 1: ASK QUESTIONS

Begin by discussing the symptoms of the issue with the person reporting it. If you think about it, how can you solve a problem if you don't know what the problem is? Asking the right questions in this first phase of the support process is vital to enabling a successful resolution.

STEP 2: REPLICATE THE ISSUE YOURSELF

Sometimes the information you've gathered in the first step might not quite paint the full picture of the situation. When I try to replicate the issue, I often gain insight into what the user is actually reporting.

STEP 3: CHECK THE LOG FILES

A well-built system will provide evidence into what is happening in the event something is not working properly. If you're lucky, error messages will provide the context for understanding the actual problem. Even if the system hasn't generated any error messages, the system logs can often provide details regarding behind-the-scenes issues in a script or database transaction. Analyzing these messages can often reveal the issue at hand.

STEP 4: TRACE BACKWARDS

Start at the point in the system where the issue has been reported and trace backwards. For example, let's assume the user is experiencing an issue on a specific application screen. Begin drilling down into the specific elements of the screen that are not working—a button, for example. Dig into the code/function behind the button to see how it's supposed to work. Perhaps the button triggers a script that queries a database for data, but that data isn't displaying on the screen. Tracing through these individual elements/functions can often help you understand where in the process the malfunction occurs.

STEP 5: RESTART/REDEPLOY THE SYSTEM

Usually, it's not going to be possible to restart servers in a manufacturing system without taking down other, still functioning, parts. However, I find it amazing how simply turning it off and on again will often fix a system when some underlying aspect gets out of sync.

STEP 6: DOCUMENT THE FINDINGS

It's always good practice to document the issue, both for the customer's benefit and to provide insight to the support team. One of the main benefits of documentation in a support situation is to provide some guidance should the same situation reoccur. You don't want to spend valuable time trying to reanalyze an issue if you don't have to.

There's nothing revolutionary in my six-step process, but I find it's a workable model for helping me find, analyze and correct system issues. If you have a similar best practice, please share it with us!

> **Troubleshooting, like coding, is a unique and special set of skills, and each person might have a slightly different approach to resolving an issue.**

Getting the Right Information From Big Process Data

Operational data can help drive strategic decision-making. But we must take care to not overlook the importance of operators having the information they really need.

*By **David Lee,** department manager, Avid Solutions, www.avidsolutionsinc.com*

In the automation world today, we see a heavy emphasis on using operational data to drive strategic decision-making within an organization. There is certainly a lot of value in this, and the ability to make near real-time data available to decision-makers can offer a significant competitive advantage. However, we must be careful to not overlook the importance of operational personnel having the information they need to make tactical decisions—decisions that have an immediate and significant impact on safety, throughput, and quality.

This information—which I like to call Big Process Data (BPD)—is targeted at operators, often presented to them through their human-machine interface (HMI). It is imperative to carefully ensure that the definition of an HMI considers not just the process control system (PCS) screen, but any system that can provide information to the operator, such as a hardwired alarm panel, pneumatic control board, historian, lab information system, or video camera.

Sounds obvious, right? Unfortunately, experience suggests otherwise. Before we begin to look at information presentation, it is essential that the fundamental elements of the system are working as designed. Properly functioning instrumentation is essential—it should be specified correctly, installed correctly, maintained, and calibrated periodically. How often do operators simply tolerate instruments that are not working or known to be inaccurate? This is often identified by the number of PCS overrides in place, alarms inhibited, or controllers operating in manual. How many companies capture this sort of information as monthly key performance indicators (KPIs)?

Once we have a solid foundation, we can start to concentrate on providing the operators the information they need. The basis of a good HMI design is a thorough understanding of how the plant will work and how the operator interacts within. This can be accomplished by using one of the many formal task analysis methodologies to capture important information. I find that using a physical model—such as that in ISA-88—in the early stages of the design can offer big dividends. Performing this ground work will facilitate a task-based HMI design and coherent alarm configuration.

Hopefully, at this point, the operators have strong real-time data. We can further help them not only by putting data in a physical and operational context, but by providing tools to put the data in a temporal context. This is where historians play a big part: By allowing operators to view past performance, we can provide them a way to predict future performance and proactively address potential issues.

We refer to an operator's situational awareness as the ability to detect, diagnose, and respond to abnormal situations, and attempt to move them from a reactive to a proactive operational stance. Often, we have a very narrow view of what this means; therefore, it is important we do not lose sight of other sources of BPD. These need to be tightly integrated within the HMI to be of real value, for example:

- Video: real-time view of equipment or location (to detect leaks or mechanical breakdowns).
- Laboratory information systems: near real-time quality information on which to base process adjustments.
- Communications: not only radio to the field, but between operators as handover logs to maintain situation awareness across shifts.
- Building automation systems: often processes are susceptible to changes in temperature or humidity within the building.
- Weather information: outside equipment, such as distillation columns, can be impacted by rain events.
- Geo-positioning: real-time tracking of resource locations (such as load trucks in a mine).

Finally, we must remember to be cognizant of human limitations—even with the best-quality information, an operator who is overloaded or fatigued is not set up for success.

None of the above should come as a surprise. My message is that as we look to spend capital dollars, it is wise to make an honest determination of where it will have the greatest short- and long-term impact.


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5 Principles of Flexible Assembly Line Design

By following these principles of flexible assembly line design, manufacturers can pursue lean manufacturing in their current operation while also building capabilities to maintain or add lean improvements in the future.

*By **Mark Sobkow,** vice president of manufacturing solutions, RedViking, www.redviking.com*

Lean manufacturing seeks to make clear what adds value by reducing everything else. Lean is clearly not a fixed-point objective; accelerating global market competition demands operational flexibility to achieve lean objectives. Here are five principles where flexibility can be added to an existing assembly line to eliminate waste and build quality into the system.

MAKE YOUR MACHINES DO MORE

Consolidating machine functions and using docking station architecture are two great examples of how to make your machines do more.

Automotive exhaust system producers have been extremely successful at effectively implementing docking station architecture. Where they once created a dimensional gage, a leak test machine and a weld station for every part, they have now isolated uniform functions such as the programmable logic controller (PLC) and barcode reader, and placed them on a dock. Wheeled fixture stations are created for unique parts and hooked to the docks with quick connects. Significant waste is eliminated by retaining the docks through multiple part and fixture modifications.

Helicopter powertrains were tested on dynamic test stands built for each unique helicopter. Today, the industry is moving to flexible designs with interchangeable gearboxes and dynamic motor configurations.

DESIGN FOR THE FUTURE

Though it's not possible to accommodate all future production requirements, designing a flexible assembly line to accommodate future capability and adaptability will set you apart. A couple examples include an aircraft and a jet engine manufacturer.

In the first example, an aircraft manufacturer was taking up to 70 hours to measure and cut doors and hatch covers. Rather than simply automating the cutting process, they instead chose to integrate a laser radar point cloud into a robotic cutting path. The current process takes less than 10 hours. Because they studied the process in its entirety, they now have future capability to precisely measure and cut doors for all future aircraft.

In another case, a jet engine manufacturer needed to exponentially increase capacity. They began the process with an engineering study and simulation, which clearly identified potential bottlenecks and areas for functional consolidation. Again, their evaluation of the process as a whole has enabled them to create a plant operation that will be flexible for future engine designs.

DETACH YOUR FACTORY FROM THE FACILITY

The separation of plant infrastructure from machines and data is crucial. Some factories have gone so far as to remove all plumbing.

Automated guided vehicles (AGVs) are a staple of material handling, but their use in manufacturing has only recently accelerated due to changing technologies. AGVs are a way to improve assembly line flexibility, improve quality, and eliminate waste. Even manufacturers of very heavy equipment are using inductively powered AGVs. Generally assumed to require full tear-out, AGVs can in fact be implemented incrementally.

By moving data acquisition and analysis onto mobile devices, operators and managers can respond more quickly to new plant information such as bottlenecks, starved stations, and machine downtime. On the data acquisition side, barcode readers can be replaced with mobile devices to track part inventories. With mobile data analysis tools, managers can remotely identify and address production problems and dispatch service staff.

DON'T BE AN ONLY CUSTOMER

There are risks in customizing commercial off-the-shelf (COTS) software and choosing specialty controls. Avoid becoming the only customer of a particular software or controls implementation

Plants often choose COTS manufacturing execution system (MES) software because of its functionality, but then modify it so heavily that their internal programmers become the only experts for their system. Plant improvement programs could then be constrained by programming resources. By choosing your MES based on widely accepted industry programs—such as Oracle or SQL—plant operations gain access to a wide base of programmers.

When controls are selected based on a unique application, the same risk exists. By choosing industry-standard controls—such as Siemens and Rockwell—a plant significantly expands its pool of controls engineers.

DON'T OVER-AUTOMATE

Seek guidance on when to automate and when to retain manual processes. As system integrators, we look at every manufacturing problem as an opportunity for brilliantly engineered automation. At the same time, we understand that every piece of automation needs to earn its place on the line. This means that there are plenty of times when manual processes should be retained.

Deciding when to automate or not? Ask yourself these five questions.

By implementing these five principles of flexible assembly line design, manufacturers can pursue lean manufacturing in their current operation while also building capabilities to maintain or add lean improvements to future operations.

See this article online at http://awgo.to/fiveprinciples for links to additional information on this topic.

Network Resiliency on the Manufacturing Floor

Unplanned downtime is a significant detriment to any business. In order to make sure that processes remain uninterrupted, consider implementing these resiliency protocols when designing your industrial network infrastructure.

*By **Ricardo Romero,** system analyst, Interstates Control Systems, www.interstates.com*

On the plant floor, communication uptime in the manufacturing process is a top priority. And—for any business—ensuring the supply-chain process remains uninterrupted is also a top priority. Corporate and industry standards, and many other factors, play into the level of robustness and system availability on a network. A resilient network reduces the risk of unplanned downtime on the plant floor and application communication downtimes.

Resilient network technologies include layer 2 protocols, EtherChannel, and others, which can be used to construct a loop-free logical topology and are designed specifically for Ethernet networks. The primary function of a spanning tree protocol (STP)—a layer 2 protocol—is to prevent loops and broadcasts but can also be used to provide redundant links if the active links fail. Consider a ring topology—at the switch- and device-level—for automation applications that require high-speed convergence and single fault recovery for perpetual manufacturing. Many automation devices have embedded switch technology which allows them to participate in ring topologies. Select a topology that meets the performance, cost, and spatial requirements of your industrial applications.

Convergence times are defined as the time it takes a switch port to go from forwarding to blocking on a ring port and blocking to forwarding on another. The IEEE and industrial network hardware manufacturers have also introduced significantly faster protocols with quicker convergence times in the low milliseconds. Some examples of convergence times of the resiliency protocols are: 1-3 ms for a Device Level Ring which is supported on Allen-Bradley hardware, 30 ms for N-Ring which is supported on N-Tron hardware, and 250 ms for Rapid PVST+ which is supported on most common switching hardware.

It is important that the application requirements are understood when selecting a protocol, such as the type of traffic (motion control, time sync, and I/O and safety control), Requested Packet Intervals (RPIs), and bandwidth. Most major vendors have tools or charts that can assist with determining which protocol will work best.

Convergence is controlled by a manager or supervisor and is typically applied to a primary switch which monitors the health of the ring topology via ring packets. When the role holder stops receiving health check packets, it converts the ring topology to a linear bus topology by blocking one of the ring ports in a matter of milliseconds, depending on the protocol used. Convergence times in an industrial network architecture must be considered to avoid application and device timeouts due to connectivity failure. Human-machine interface (HMI), message instructions, I/O, and produce tags are a few examples of network connections that must go uninterrupted.

To support further resiliency and real-time communications, any latency and jitter can be minimized with the use of Internet Group Management Protocol (IGMP) to control the delivery of multicast traffic and the use of Quality of Service (QoS) to achieve real-time requirement of multiple types of traffic flows.

Remember to include these resiliency protocols as a topic of discussion in your next design meeting and you will be on the way to a 100% production uptime status.

> **It is important that the application requirements are understood when selecting a protocol, such as the type of traffic (motion control, time sync, and I/O and safety control), Requested Packet Intervals (RPIs), and bandwidth.**

Are You Protecting Your Most Valuable Assets?

Safety in manufacturing is nothing new. And though an investment in safety can do so much for a manufacturing plant, it's something that can easily be ignored or pushed to the side.

*By **Brian DeFanti,** project engineer, Avanceon, www.avanceon.com*

In today's world, safety seems to be at the forefront of many peoples' mind. However, in the last century, that was not always the case, particularly in manufacturing.

I was recently involved with an upgrade project where the sole purpose was to add complex, safety protection to an old but powerful line of equipment that previously had none. The equipment was designed and placed into production sometime in the mid to late seventies—a time when the idea of safety was "out of sight, out of mind."

Back in those days, there wasn't as much thought put into potential hazards like protection from pinch points—the machine's potential to grab a finger, hand, clothing, or an arm—and an overall consideration of the machine's fast motions that, in the event of an emergency, cannot stop quickly enough.

In order to address these problems, the brains of the project included a new safety programmable logic controller (PLC) processor combined with several safety I/O cards. This processor was programmed to monitor an array of safety rated limit switches, light curtains, and emergency push buttons. The limit switches were partnered with electronically, lockable guarding gates designed to keep the operators out of critically dangerous areas until the process came to a safe and complete stop. The light curtains were also designed to bring the process to a safe state if an operator crossed over one or more of the beams in the sensing field.

The production line was separated into several safety sections. Depending on which safety inputs were tripped in each section, the PLC would instantly shut down corresponding safety air valves, hydraulic valves, or motor starter contactors. This setup allowed some pieces of equipment to be safely locked out, while other sections were able to keep producing, but only as long as the safety permissive needed for those sections were met.

While many companies claim that safety is their number one goal, it's all too common that safety upgrade projects—such as the one above—are put into place too late, and only after damage or personal injury has occurred. Most manufacturing companies know and understand the importance of allocating resources to protect, maintain, and improve their capital assets. But what's a company's greatest asset?

It isn't the equipment or physical plant, and it isn't data. The most valuable part of a company is its people—the human capital. By investing in workplace safety, companies can attract and retain quality employees, operate more efficiently, and enjoy a healthy bottom line.

How is your company making appropriate provisions to protect its most important assets?

Testing, Testing. Developing, Developing. Discover Test-Driven Development

Develop document and code for an automation project easier and quicker with a method that develops a little, tests it, then develops some more.

*By **Duane Grob,** principal engineer, Avanceon, www.avanceon.com*

Back in 2003, Kent Beck and David Astels first proposed the concept of test-driven development (TDD) as a new approach to develop project code. Simply explained, the concept postulates that for each step in the development cycle, only enough application code should be created to successfully complete a given test requirement. Developers begin with a simple test requirement and revise the code until the test is successful. They then create the next test, develop the associated code and continue the cycle. As the process moves forward, the developers refactor/retest the code to ensure nothing broke while new tests were incorporated into the application requirements.

This all sounds good, but how do we leverage this concept for automation applications?

Typically, we're tasked with defining the requirements for a system as a separate documentation effort from test protocol development. This, in turn, is separate from the actual code development. In short, this means we might develop requirements and then develop the application code and the test scripts in parallel.

Lots of development going on here—but many projects can't support the cost and time required for such an effort.

By looking at a test design prior to any code development, we eliminate the separate task of creating requirements for our code. More precisely, we incorporate requirements development into the test protocols, minimizing or eliminating the unique phase of creating a specification.

Simply put, you define the requirements of the application by specifying the test that will verify the requirement is satisfied correctly—then write the code for that test. You test the code and modify it until it passes the test, then move onto the next required test.

The reality is you will likely have many tests defined prior to writing your first bit of code, but you could write and test one at a time. Some of this becomes redundant, especially if you have a library of proven, quality code from which you can draw. It's just more efficient to test when you have only written a few lines of code rather than after you've written several hundred (or thousands) of lines.

The objective here is to develop clean code that meets the test protocols in a short time, with sufficient documentation to develop, test, and verify that the application is sound. Many clients have little or no specifications or requirements and prefer to not purchase design documents. We have all seen projects where the expected results are "obvious" or "easy" and only require a few hours of dialog with the owner/end user in order to proceed. However, we always need a way to test and verify with the client that what we have developed is indeed what they want.

The other advantage of TDD is it can apply to more than just code development. You can also use it to define and test hardware implementation and unit and system architectures. In the end, your test document and requirements specification are one and the same and complete before any code is developed, hardware is purchased, or field work is executed.

I suggest you try this on a small project first and verify for yourself that you can develop documentation and code easier and quicker. You're more likely to have a successful project and happy client to boot!

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