Control Engineering

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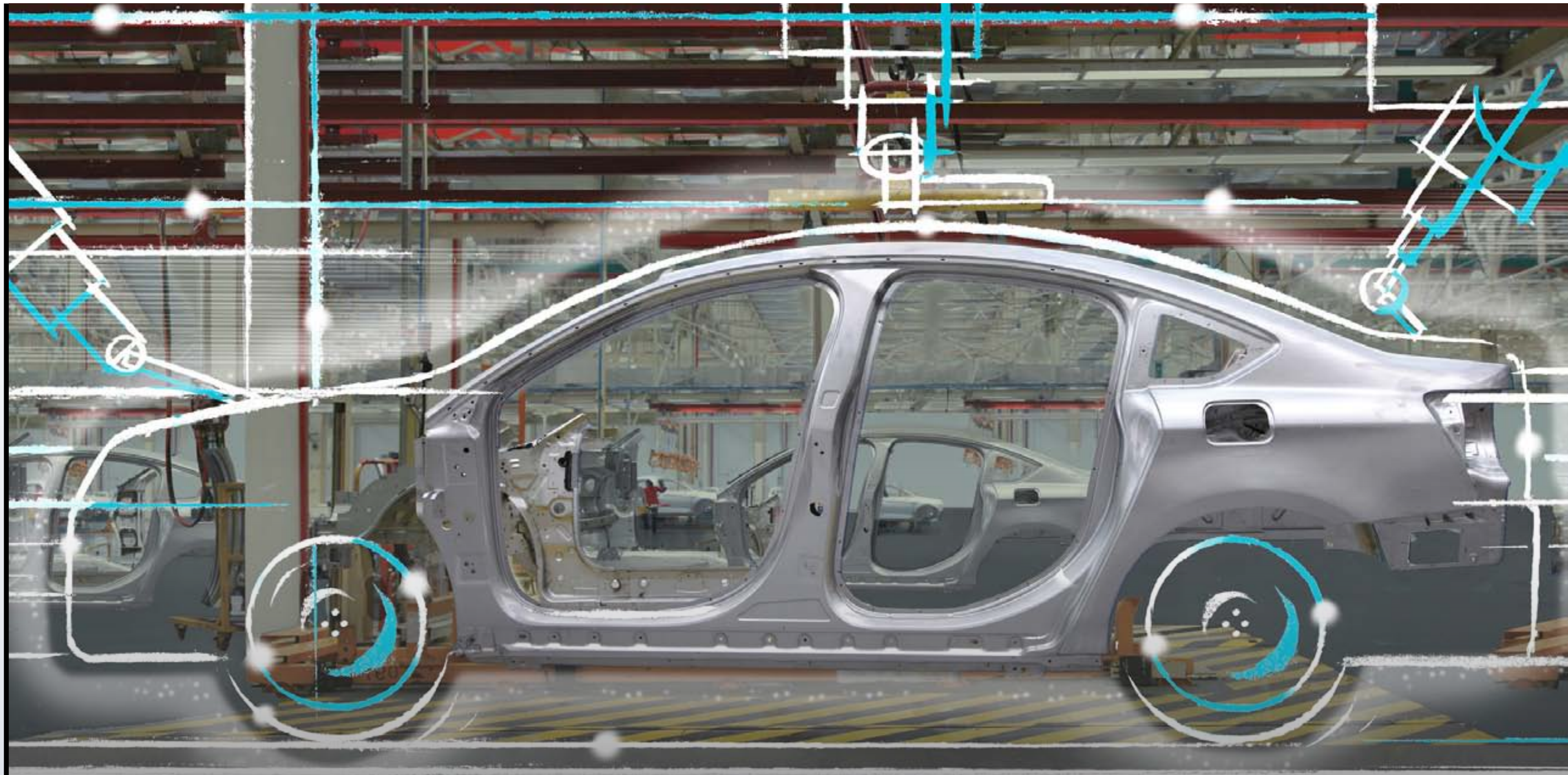

Optimize Automation with Lifecycle Management

Sponsor Overview

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IEC 61131-3, CoDeSys Standardize Control Logic Programming

Ease control programming across multiple controller platforms using IEC 61131-3 CoDeSys programming software. IEC 61131-3 standard programming drives efficiencies through reduced development and training costs, enabled flexibility, and allowing end users to select the device most suited to their needs, regardless of supplier.

By Richard C. Harwell, Kerry L. Sparks, Eaton

Control logic programming standardization promotes interoperability and saves engineers time when working with products from multiple vendors. IEC 61131-3 standard programming drives efficiencies through reduced development and training costs, enabled flexibility, and allowing end users to select the device most suited to their needs, regardless of supplier. Designed around that standard, CoDeSys (Controller Development System) software technology opens new roads for the automation industry—including creating controller applications without hardware and programming on a common platform.

In December 1993, the development of IEC 61131-3 was a groundbreaking effort to bring standardization to logic programming. It provided a core programming model with several inherent benefits, including:

- Structured software based on Program Organization Units (POUs)
- Strong and consistent data typing
- Task based execution control.

Beyond the standardization of program structure, IEC 61131-3 defined a standard set of programming languages: ladder logic, function block, structured text, instruction list, and sequential function chart.

By providing a common programming model and language set, the standard has allowed control engineers to work effectively with controllers from different suppliers. This has allowed them to easily understand programs generated for various logic controllers. Additionally, the task of porting a program from one supplier's programming software to that of another was reduced.

Even though there are many benefits to an IEC 61131-3 program model and languages, control engineers have found themselves "locked in" to one supplier's equipment. The IEC languages were a step in the right direction; while the program model and base languages may be the same, there are still some large differences:

- Supplier-specific language extensions can prevent interchangeability among control hardware manufacturers
- Look and feel of the programming environment can make it difficult to program on one controller versus another
- Program file storage formats can create compatibility issues with different memory organization, even with the same manufacturer.

Changing among suppliers of IEC 61131-3 controllers can require staff retraining and manual program re-entry. CoDeSys software technology provides an easier-to-use, flexible platform for use of the IEC 61131-3 programming standard.

CoDeSys, a comprehensive open software tool for industrial automation, consists of two parts:

- The programming system CoDeSys, a Common IEC 61131-3 programming tool
- The runtime system CoDeSys Control, which turns any intelligent automation device into an IEC 61131-3 controller programmable with CoDeSys.

The system is designed to easily adapt from one vendor "target" device to another. This means that a control engineer can incorporate multiple targets into one programming environment or move from the programming environment of one CoDeSys controller to another, without retraining. Additionally, program file formats are common and programs can be imported without manual intervention.

Commonality of the CoDeSys Control runtime environment across targets means that a program operates similarly on the new target. Ability to reuse proven control code provides a high level of quality assurance in the critical runtime environment. CoDeSys Control runtime system can deploy on many devices capable of control, like PLCs, operator interfaces, and drives. It is ideally suited to support the trend towards control distributed to end devices (such as operator interfaces and drives), while still allowing best-of-class selection of those devices.

CoDeSys is helping to propel the IEC 61131-3 standard into the future and is increasing adoption by making it simpler to use devices from multiple vendors. It enables end users to select the devices best suited to their needs, by reducing the costs and time associated with migrating from devices manufactured by different vendors.

Richard C. Harwell is Advanced Solutions Manager, and Kerry L. Sparks is Senior Field Marketing Specialist at Eaton.

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Back To Basics: Simplify Device-Level Wiring

Faster connectivity, data monitoring, and circuit protection are among advantages of device-level wiring solutions.

By Richard P. Chung, Product Manager, Eaton

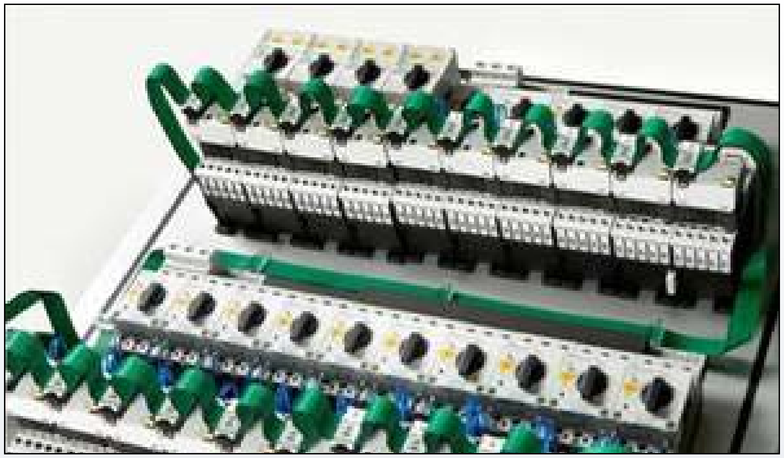
Innovative, user-friendly, device-level networks can provide original equipment manufacturers (OEMs) with an intelligent connecting solution that reduces commissioning time, improves wiring accuracy, and simplifies troubleshooting. Ultimately, they can help to drive increased profitability. That said, not all networking solutions are well suited for use within a control panel. Control panels perform a wide range of applications and have specific connectivity requirements that are not adequately handled by every network. Consider the following criteria:

SmartWire-DT is a control panel wiring solution that allows OEMs to simply connect motor control devices on a panel using a flexible flat cable, eliminate traditional point-to-point control wiring, help protect control interlocking, and provide data monitoring of connected motor loads.

- **Simple connectivity.** Is the cable media flexible enough to route to the devices in the panel? Ensure the connectors are easy to locate and connect to the cable. To minimize setup time, the connecting solution can have auto-addressing capabilities as well as accommodate both device control and power needs. Furnishing the panel building process with new solutions can improve throughput and profitability. Lastly, to ensure simple connectivity, the cable media should be able to extend both inside and outside of the control cabinet.

- **Composition of I/O connections.** The composition of the I/O connections will determine which type of device-level network is best suited for a control panel. Does the control panel I/O consist primarily of motor-control type connections (like motor starters, contactors, relays, and pilot devices)? Or, is more than a third of the I/O connected to position sensors? Networks that are primarily composed of motor starters and pilot devices can use connecting solutions that have a built-in communication system and integral diagnostics, allowing you to easily troubleshoot and improve wiring accuracy. On the other hand, control systems which require numerous sensor inputs may be better served with device-level networks that include quick-connect type cable connections and cord sets.

- **Data monitoring.** Increasingly, end users want data monitoring on some or all of their motor loads. In traditional PLC-control systems, this data is provided by current transformers (CTs), which are wired back to analog inputs on the PLC. Device-level networks can connect to electronic manual motor protectors (MMPs) or overload relays—the information can be monitored over the network, without using CTs or analog inputs to the PLC. Furthermore, the space requirements for electronic versus electromechanical MMPs or overload relays is about



Eaton SmartWire-DTTM panel wiring solution

the same, so it is feasible to upgrade or retrofit control panels and/or to have this option on a larger number of motor loads.

- **Design flexibility.** Does the end user specify the preferred brand of programmable logic controller (PLC)? How does this impact engineering, documentation, and panel layout? Smart, device-level networks can help to standardize the control panel by eliminating the need for traditional PLC input/output (I/O) modules and use motor control components that can connect directly to the network. There's no need to reconfigure the control panel layout and wiring for different PLCs.

- **Control circuit protection.** Is it difficult to troubleshoot after someone changes the panel wiring after installation? How do you prevent someone from bypassing or removing the safety interlocks that are part of the control design? Today's device-level networks can deter unauthorized wiring changes and help prevent control wiring interlocking from being bypassed or jumpered. Additionally, device-level networks employed today can continuously monitor all devices on the network and detect changes in status or configuration.

- **Standardization.** Do you build multiple control panels that have the same or similar configurations? Do you offer optional devices for the control panels? Do you have to reengineer to change the panel wiring to accommodate these options? Intelligent, device-level networks speed design, assembly, test, and commissioning by eliminating or reducing point-to-point wiring and use quick connectors to connect control devices. They can significantly reduce the wiring effort required to build panels; some allow you to replicate the connection wiring harness—saving costs and time. They allow programming of the optional features in advance, automatically detecting when optional devices are present. This allows you to have one PLC control program, one wiring layout or connection harness, and control panels that can easily be field upgraded.

Richard Chung is Product Manager at Eaton.

Create Value With Re-Use

When you finish a project, begin working to catalog what was built, the standards used (and improved), and where and how that work could be applied in future. Not-invented-here syndrome is a common challenge in system integration and with engineering in general.

By Anthony Baker, Callisto Integration

How much re-use are you getting out of your projects? In other words, when you finish one project what parts can you directly apply to the next? As a specific example we often ask the question:

- How many projects can a great Functional Design Specifi cation (FDS) affect *before* the start of a project:
  - **One**
- How many projects can a great FDS effect *after* the project if time is taken to complete the as-built document, add screen-shots with callouts, and file with an appropriate version number in a public space for sharing?
  - 10? 20? **Many**

Why then do so many projects drop the ball after the project is complete and walk away without working to catalog what was built, the standards used (and improved) and where and how that work could be applied in future. Not-invented-here syndrome is a common challenge in system integration (and engineering in general) but if we can get move past this the potential for both individual project success as well as long term growth of the integration industry is huge. As a summary, the chart details the integration project costs (both as dollar and percentage values) for a two-plant install between continents. The Plant 1 design and implementation contributed directly to Plant 2. All efforts listed represent direct integration costs only.

Further to the direct integration benefits of re-use, client-centric benefits include:

- **Lower project risk** – Components identified as new/different are noted as risk factors and engineering effort is spent up front mitigating that risk. *As an example, a set of pre-built VM servers that can be re-used from project to project will lower the risk of incorrect software install order, unsupported patch installations, or other configuration errors, which can result in longer setup and commissioning time.*
- **Lower support cost** – If the same standards are used across multiple sites or lines, the net training effort required for the organization drops significantly. *As an example, a video-recorded training presentation which outlines application navigation and troubleshooting can be created and viewed in multiple plants and multiple languages with only one investment in content development.*
- **Lower threshold for improvement** – as an improvement is identified it can be quickly copied from one plant to another. As an example, a recipe improvement in one

plant could be electronically submitted to another for next-day business return on investment (ROI).

- **Lower per-project design cost** – Re-using software from one project to another has a direct, positive impact on business project management costs such as the total time required by H.B. Fuller employees in software reviews (43 vs. 2 as outlined in previous graph)

In summary: change your focus. What you do after commissioning should be held in as high regard as what you do before.

Anthony Baker strikes again: Anthony Baker is a fictitious aggregation of experts from Callisto Integration, providing manufacturing consulting and systems integration. This blog provides integration advice in plant-floor controls, manufacturing execution systems (MES), and manufacturing consulting, from the factory floor through to the enterprise. Andrew Barker, P.Eng., Callisto Integration, compiled the advice.

www.callistointegration.com

Control Panel Before and After: Gain Productivity with Lean Automation, Connectivity

Get wired for efficiency. This video, photos, and text explain how a cabling system can speed control panel design and construction, with build-time control panel assembly savings of 60% or more.

By Mark T. Hoske, Content Manger, *CFE Media, Control Engineering, Plant Engineering* and *Consulting-Specifying Engineer*

Machinery original equipment manufacturers, panel builders, and others can more easily see the productivity, reliability, and economic advantages of using a smart-module-type device-level wiring system when compared to a conventionally wired control panel.

Lean automation helps streamline control panel design on the right, producing overall savings of 35% and build time savings of 60% or more. Richard Chung, product manager, lean automation, Eaton, explains to CFE Media's Mark T. Hoske how the Eaton SmartWire-DT system helps with that, at the Eaton Menomonee Falls, Wis., facility. Video is about 9 minutes. http://www.controleng.com/single-article/control-panel-before-and-after-gain-productivity-with-lean-automation-connectivity/b457ded5a1611d12644a2532865082d4.html
Courtesy: *CFE Media*

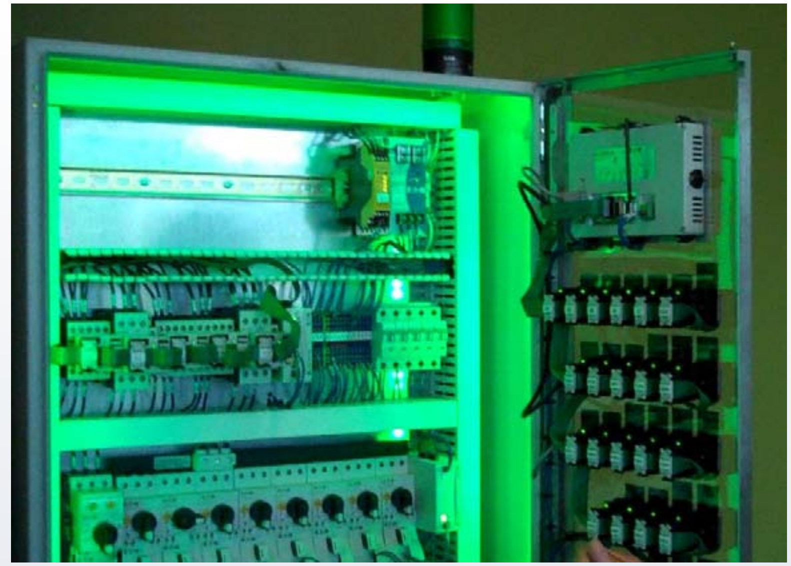
In an interview with CFE Media, Richard Chung, Eaton product manager for lean automation, explained how to streamline control panel design to produce overall savings of 35% and build time savings of 60% or more. Below, Chung discusses traditional design control and electrical panel design and lean automation design, along with advantages beyond the obvious wiring savings.

Traditional control panel

Before: On the left in the first photo and beginning of the video is a composite control panel design using standard electromechanical controls, with multiple pushbuttons and an operator interface on the door of the controls enclosure. (Enclosures here have clear covers for display purposes.) Inside the panel are basic motor starters and motor protectors, wired to contactors. On the top is a programmable logic controller (PLC) and I/O modules hardwired to the components on the door. While this demo panel packs in what typically would be in a larger panel, it does illustrate, in close proximity, the effort required to strip, route, connect, add wire markers, and bundle and secure all wiring and cabling so it's neat and orderly. It takes a lot of time and can result in additional challenges with loose terminations or wire connections. An original equipment manufacturer or panel builder would check the wiring using a schematic diagram, yellow-lining the paper during the process to show what had been wired, for a thorough check.

Lean control panel

After: On the right of the first image and video is a lean solutions control panel using a lean connectivity system with a multi-conductor flat cable connection, which consolidates eight wires for smarter and faster wiring. A smart chip is embedded in each of the control components shown—contactor modules and pilot device modules (pushbuttons)—so they can communicate in distributed fashion with the main controller. Benefits include space savings through elimination of the traditional PLC, I/O modules, and associated wire channels. PLC functionality has been combined into the hardware of the operator interface, running a Microsoft Windows CE real-time operating system, with CoDeSys software runtime engine for the PLC code and visualization. The software, offered by more than 200 suppliers, eliminates the need to change PLC application programming. It uses IEC 61131-3 languages.



The flat cable plugs into the back of the HMI-PLC unit, eliminating a gateway or communication card. It connects serially to other control panel devices using a snap-in connector for each. Courtesy: *CFE Media*

A trip condition can provide a local alarm indication and notification via the Internet. In an overload situation, the contactor can open, disconnecting the load before the circuit breaker can trip, so a remote restart is possible without a visit to the enclosure.
Courtesy: *CFE Media*

The flat cable plugs into the back of the HMI-PLC unit, eliminating another piece of hardware typically required, a gateway or communication card. It connects serially to all devices in the control panel using a snap-in connector for each. By simplifying and standardizing the way components are connected inside the control panel, the system reduces overall control panel size, eliminates hardwiring to remote I/O modules inside cabinet, and streamlines diagnostics and other communications outside the cabinet.

Beyond a footprint reduction, the system also can add functionality to an existing enclosure, such as when a retrofit application needs to add PLC and operator-interface functionality, but there isn't space with traditional design methods. Those changes can be made to an existing box with minimal changes to the existing design using lean automation.

Machinery original equipment manufacturers and their customers can take advantage of remote diagnostics with web server capability on the controller and easy connection via Ethernet to the Internet to limit downtime. Courtesy: *CFE Media*

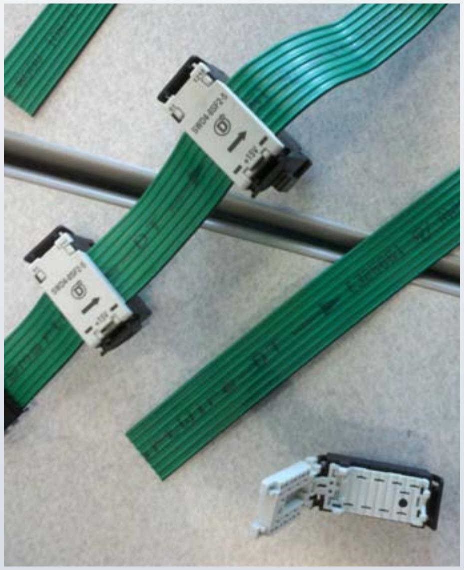
Machinery original equipment manufacturers (MOEMs) and their customers also seek more remote troubleshooting functionality, which this enables, with web server capability on the controller and easy connection via Ethernet to the Internet. Such a connection allows (with appropriate security clearance) remote diagnostics—the ability to troubleshoot an outage or other malfunction remotely. In this way, repairs may be done in minutes, compared to many hours if an off-site MOEM technician needs to visit.

Wiring, space, diagnostics, productivity

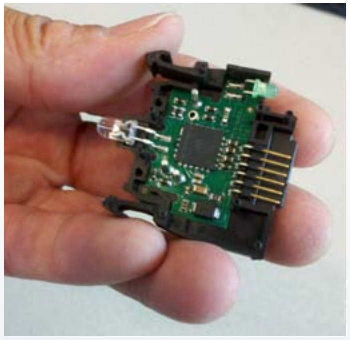
Savings: Typical before-to-after savings is 35% overall, with build-time savings upwards of 60% or more, depending on the mix and configuration of the control panel. It avoids individual wire cutting, stripping, wiring identification, and the need for applying wire ferrules. Upon connection, the system locates any faults, though the flat-wire connection system helps to avoid errors.

Beyond faster time to operation, the system also can deliver more information about motor loads and other connected systems to streamline maintenance, perhaps avoiding typical scheduled technician visits in favor of remote monitoring. It can tap into the electronics of the motor starter, monitoring motor current, for instance. When settings are changed or thresholds are crossed, the results can be seen online, if needed.

Online diagnostics can reduce risk by eliminating the need to visit or open enclosures where personal protective equipment (PPE) is needed, even allowing remote reset capability after a trip condition. In an overload situation, the contactor can open, disconnecting the load before the circuit breaker can trip, so a remote restart is possible, without a personal visit or suiting up with PPE to open an enclosure.



To locate a device using Eaton SmartWire-DT wiring, clamp the module over the desired location, and crimp. An open module is shown at the bottom. Courtesy: *CFE Media*



Onboard communications inside each Eaton SmartWire-DT module helps improve speed to start-up over traditional control panel wiring. Courtesy: *CFE Media*

Eaton SmartWire-DT crimper, right, pushes the module closed over the flat wire. A connected Eaton pilot/pushbutton is shown, left. Courtesy: *CFE Media*

Road show education

A multi-city U.S. Eaton road show has been detailing the advantages of lean automation, integrated modular components, use of CoDeSys, integrated HMI-PLCs for visualization, simpler integrated safety designs, web-enabled machines, diagnostics, energy awareness, and energy efficiency. The information above was gathered during a pre-event interview in July at the Eaton Innovation Center in Menomonee Falls, Wis.

Mark T. Hoske is Content Manager, *CFE Media, Control Engineering, Plant Engineering,* and *Consulting-Specifying Engineer,* mhoske@cfemedia.com

Online extras

Watch the related video.

http://www.controleng.com/single-article/control-panel-before-and-after-gain-productivity-with-lean-automation-connectivity/b457ded5a1611d12644a2532865082d4.html

Panel building: Optimizing control panel design, construction– This article provides additional details and justification.

http://www.controleng.com/single-article/panel-building-optimizing-control-panel-design-construction/a002424d1a12ce0bd619061ee28f6b14.html

Time, material savings mean cost savings – This article includes tables with time and material examples.

http://www.controleng.com/single-article/time-material-savings-mean-cost-savings/cb7d279a-1766f084a43a72c4d8eac0ea.html

Key concepts

-Control panel design can benefit through use of a modular cabling system
-Control enclosure assembly build-time savings of 60% or more can result compared to traditional methods
-Updated designs can lower safety risk and increase uptime with diagnostics and remote monitoring capabilities

Consider this

Are modular panel design tools and techniques saving you time and money?

Whitepaper: Panel Building–Optimizing Control Panel Design, Construction

Modern control panel wiring methods can reduce the costs of manufacturing and ownership.

By Richard P. Chung, Product Manager, Eaton

Overview

Global pressures and decreased time-to-market challenge manufacturers to embrace Lean concepts and use innovations to maximize their competitive effectiveness. Recent technology advancements intended to modernize conventional control panel wiring are transforming how panels are designed, built, commissioned, and maintained (see Figure 1).

Every year, the bar is raised on competitiveness. New technologies and innovations, and more effective manufacturing practices, propel us to higher levels of productivity. The U.S. Bureau of Labor Statistics reported that labor productivity increased in 83 percent of the 86 manufacturing industries studied in 2010, with 57 percent of these industries posting productivity gains of 6.1 percent or more as opposed to 2009, when 40 percent of industries recorded productivity losses. It is no surprise then that productivity is among the top five priorities for companies. The CEO Institute reports that the top five issues that keep CEOs awake at night include:

Figure 1. Recent innovations in control panel wiring methods can reduce the costs of manufacturing and ownership.

1. Improving productivity
2. Reducing costs
3. Achieving operational efficiency
4. Managing increasing competition
5. Achieving top line growth

So how do engineering managers translate these directives to drive productivity and competiveness? Instilling a broader view of initiatives and looking at the total cost of ownership over the investment cycle—instead of the initial project cost—is crucial. Driving standardization and efficiency wherever possible also helps. Increasing productivity is no longer a voluntary objective; it is required for business survival because productivity gains help to insulate businesses from negative economic impacts.

But how can a company gain a competitive advantage? The primary factors in establishing and maintaining a firstmover advantage are decreasing time-to-market and getting early feedback from customers/end users on prototype designs.

For example, the U.S. automotive market is experiencing a growth period and is faced with the challenge of reducing time-to-market for new vehicle programs. What used to take 48 to 60 months from start of program to start of production is compressed to a 24- to 30-month cycle. In other words, machinery original equipment manufacturers (MOEMs) that used to have 40 to 60 weeks of lead time from contract to delivery are now challenged to deliver equipment in 20 to 30 weeks instead.

Increasing productivity

The first step for increasing productivity for control panel building operations is to understand how costs are allocated to design, engineering, material, assembly, documentation, quality control testing, and commissioning. Material costs can range from 35 percent to 65 percent, while engineering, testing, and assembly costs make up the difference. Also, the costs for on-site installation and commissioning must be considered for system integration or turnkey operations.

Further, often-ignored and hardly documented overhead costs are absorbed—although they may actually pertain to specific projects. Some of these costs relate to pre-engineering, preliminary designs, and/or post order service help or troubleshooting at a customer's request. Although considered good will, the time required increases the cost of doing business. Increasingly, MOEMs are discovering that including some level of machine- and control-panel diagnostics allows them to help customers troubleshoot systems themselves—with a little guidance via a conference call instead of making a costly site visit.

Finding cost-reduction opportunities

But what is to be done after the best component price is negotiated and the smallest footprint and enclosure size is established? Further cost-reduction opportunities are limited by conventional hardwired control panels. With material costs a relative constant, the real opportunities for cost reduction exist in reducing control panel engineering, testing, and assembly time. Perhaps creating a standardized layout or replacing hardwired pushbuttons with a touchscreen on a control network can minimize engineering time. For example, it is typically advantageous to use a touchscreen in designs with 10 or more pushbuttons. Additionally, even using spring-cage terminals instead of standard screw terminations can reduce wiring time by about 15 percent.

Using wiring harnesses can speed assembly time and help eliminate wiring errors. However, this approach is practical only when constructing significant quantities of the same control panel. Automating mundane tasks such as wire stripping and marking can improve quality and consistency while saving time. However, this approach also requires a significant amount of repetitive panels to justify the payback. Establishing point-to-point wiring practices among assemblers can also help reduce testing and/or troubleshooting time. While functional testing typically reduces the time required to check point-to-point wiring, when something goes wrong, it can still take an unpredictable—and possibly an inordinate—amount of time to locate and correct faults.

Challenges with hardwired systems

Hardwired control panels continue to serve the automation/control industry very well. However, they present certain challenges because of the intensive labor required to:

- Cut individual control wires to the proper lengths
- Strip the insulation
- Add wire identification markers
- Add ferrules at the ends of wires

A simple control panel with a PLC and about 100 I/O points typically requires a wiring schedule or chart to instruct the assembler how to connect the PLC's I/O modules to the corresponding contactor, pushbutton terminals, sensors, or other field devices. When more than one panel is required, a wiring schedule is an efficient way to provide wiring instructions and to ensure consistency. However, it requires engineering time to create the wiring schedule. Also, with numerous wires in close proximity, wiring errors are likely. A wrong connection typically implies that there are multiple wiring errors.

More often, a detailed schematic diagram is used, which requires the assembler to interpret the diagram and keep track of all the wiring by highlighting each wired connection as it is physically wired. This is a tedious but essential practice that consumes time but minimizes the chance of not making a wired connection—which would be more troublesome to troubleshoot during the functional test stage.

When wiring is bundled to door-mounted devices, additional time is required to properly dress and bundle the wires in a way that does not restrict opening and closing the door, or does not damage the wiring bundle (see Figure 2). When wiring to small saddle-clamp-type connectors on pushbutton contact blocks, special steps must be taken to ensure that wires are inserted on the correct side of the saddle clamp, and to ensure that proper electrical connections are made. Visibility and access become increasingly restrictive as component layout density grows or as pilot devices are added to the layout matrix.

Figure 2. Additional control panel construction time is required when wiring is bundled to door-mounted devices because wires must not restrict opening and closing the door.

Finally, after the panel is wired, last-minute engineering/design changes may be required. There may be control program modifications, or the customer may wish to add (or remove) components, features, or options. These changes must be accommodated before the control panels leave the shop.

After the control panel is installed on-site, other challenges take over. Eventually, wiring duct covers may be removed to allow technicians to trace wires, control program modifications may be made, field devices may be installed requiring additional I/O wiring, or an added device/component may require wiring to be routed from the control power supply (see Figure 3).

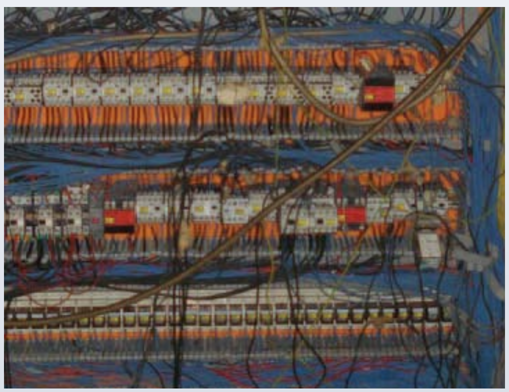


Figure 3. Typically, control panels change over time to accommodate wire tracing, configuration/design modifications, the addition or removal of control or electrical components, or tapping into the control power supply.

Wiring, layout, and control program changes usually go undocumented. Drawings are seldom updated and control scheme and programming changes are rarely recorded. However, depending on the business arrangement, the machine builder may still be responsible for the control panel, regardless of the ad hoc changes that may occur in the field.

Improving control-panel connection methods

How would reducing the number of point-to-point wires in a control cabinet affect productivity? Less wiring translates into less assembly time, fewer chances of making mistakes, less time required to check and test wiring connections, no time needed to create a wiring schedule, and more available control cabinet space.

Remember when the connections in the control panel were hardwired—before industrial control networks or fieldbuses? (See Figure 4.) Remember when the wiring between control panels consisted of home-run wiring to the main controller and I/O modules? Fieldbuses and remote I/O eliminated home-run wiring, which marked a major productivity shift in on-site control wiring and system installations.

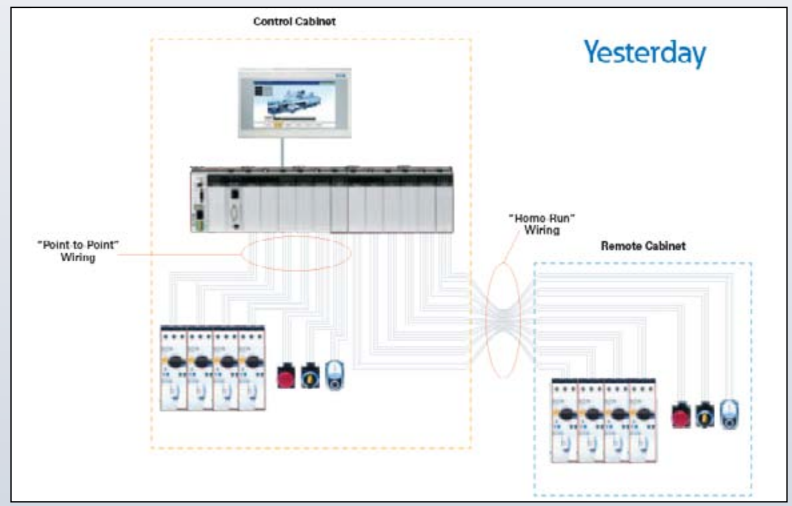


Figure 4. Before industrial control networks or fieldbuses, control panel connections were hardwired using point-to-point wiring inside cabinets and home-run wiring to and from remote cabinets.

Although the various fieldbuses greatly improved system installation productivity, point-to-point wiring is still required within the cabinet to connect control components to I/O modules. While the elimination of home-run wiring to and from field devices has greatly improved productivity, that level of productivity has not been available for wiring within the control cabinet.

What if control components could be connected to the PLC's CPU without point-to-point wiring or without the need for some of the I/O wiring? What if I/O could be distributed to the component level using an approach that is economically feasible, is functionally equivalent to point-to-point wiring (or better), and is well suited for the dense arrangement of control components normally found in a control panel?

Consider a control panel wiring method that could:

- Connect standard motor-control components
- Eliminate most hardwiring
- Accelerate the engineering, assembly, testing, and commissioning processes
- Reduce control-cabinet space requirements
- Connect to industry-standard networks and fieldbuses

Device-level wiring systems that use smart modules, which attach to standard motor control components, such as contactors, motor starters, and other control circuit devices, are now available. These smart modules connect via flat cable to a gateway module, which connects to a standard fieldbus on the PLC's CPU (see Figure 5). Device-level wiring systems that incorporate a power supply can help eliminate most of the control wiring from the PLC's I/O modules to motor starters and control circuit devices. The I/O typically associated with controlling motor starters and control circuit devices can also be eliminated.

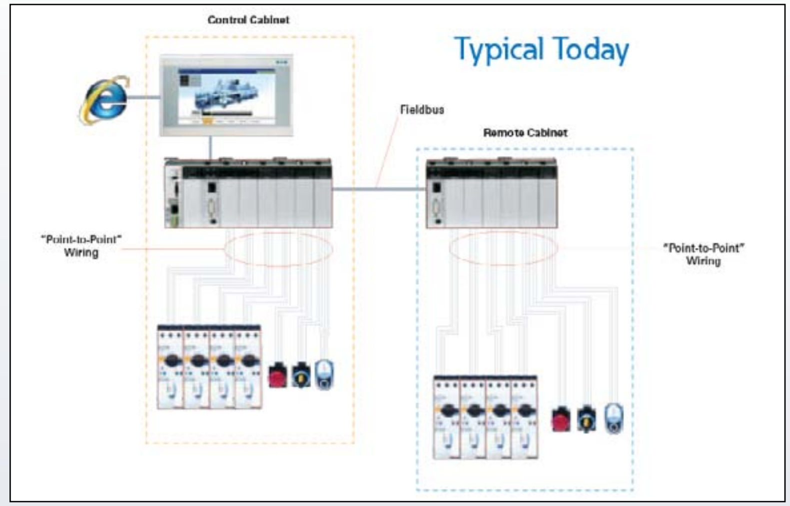


Figure 5. Device-level wiring systems use smart modules that connect standard motor control components via flat cable to a gateway module, which connects to a standard fieldbus on the PLC's CPU.

To understand the productivity, reliability, and economic advantages of using a smart-module-type device-level wiring system, compare its advantages to those of a conventionally wired control panel. A wiring duct in a typical conventionally wired panel with numerous control wires can be replaced with a flat multiconductor cable that serially connects the components (see Figure 6). Many of the PLC's I/O modules have been eliminated, which increases available panel space. Saving panel space can significantly reduce material costs when stainless-steel enclosures are required. Panel assembly time is also significantly reduced, and testing time is virtually eliminated because there is only one flat cable to check. Diagnostic LEDs on the communication modules indicate network status, which further accelerates testing and commissioning.

From a maintenance perspective, a device-level wiring system has fewer connections that must be checked periodically for termination integrity. Dual-color LEDs on the wiring system's modules simplify troubleshooting. The modules also provide access to byte-level network signals to further aid diagnostic and troubleshooting efforts.

Figure 6. Device-level wiring systems use flat multiconductor cables to connect components, replacing bulky wiring ducts found in conventionally wired control panels.

Because a single flat cable connects control components, field wiring modifications are less likely to occur. However, if and when they do, their presence is evident. This helps to protect the machine builder's intellectual property, and to preserve the original craftsmanship and quality of the completed panel.

Device-level wiring systems reduce engineering, design, assembly, and wiring time (see "Time and material savings mean cost savings"). They also simplify control connections, extend diagnostic capabilities to the device level, and increase the reliability, consistency, and flexibility of the control scheme.

Control-panel connectivity—the next generation

Whether connecting to dedicated/discrete controllers or networks of PLCs, solutions that can improve control panel engineering, construction, testing, and commissioning are available now. At last, there is a device-level wiring system/network that optimizes control panel wiring the way fieldbuses revolutionized the industry nearly two decades ago. Device-level wiring systems enable engineers and designers to rethink traditional control panel layouts, allowing them to design modular, flexible, and compact control systems while providing advanced user diagnostics for commissioning and maintenance.

Time and material savings mean cost savings

Many people say, "Time is money." However, material is too. When it comes to engineering, assembling, and testing control panels, reducing either time or materials (or both) can reduce costs significantly. Here are two examples that illustrate how reducing time and materials can also reduce costs.

In the time reduction example, the estimated time to wire motor starters, contactors, and pilot devices is 4 hours and 29 minutes. However, the estimate is only 41 minutes if a device-level wiring system is used—an 85 percent reduction in wiring time. Engineering and testing times were also reduced.

Time reduction example

	Conventional	Device-Level Wiring System	Savings
Wiring time	269 min	41min	85%
Engineering time	115 min	35 min	70%
Testing time	46 min	4 min	90%

In the material reduction example, an installation that consisted of 1,600 motor starters would have required 7.83 miles of control wiring. However, by using a device-level wiring system, only 0.45 mile of flat cable was used. Calculating the material cost of each method using $0.61/ft for flat cable and $0.14 for #14 AWG, the device-level wiring system saved more than $4,300. In addition, the calculated savings for wiring/assembly time was 22 man-days.

Material cost example

	Flat Cable	Control Wiring #14 AWG
Length (in miles)	0.45	7.83
Length (in feet)	2,362.00	41,339.00
Cost per foot	$0.61	$0.14
Total cost	$1,441.00	$5,787.00

Another significant benefit is the device-level wiring network allowed the system to be installed and commissioned without having to ring out a multitude of control wiring connections. This type of control system can also connect electronic motor starters to the system, which allows motor current and other loads to be monitored without having to add current transformers or analog input cards to the PLC.

This feature could enable a higher level of predictive data monitoring that was prohibitively expensive in the past.

www.eaton.com/smartwire-dt

Biography

Richard P. Chung is a Product Manager at Eaton. He has more than 25 years of experience in the control and automation industry.