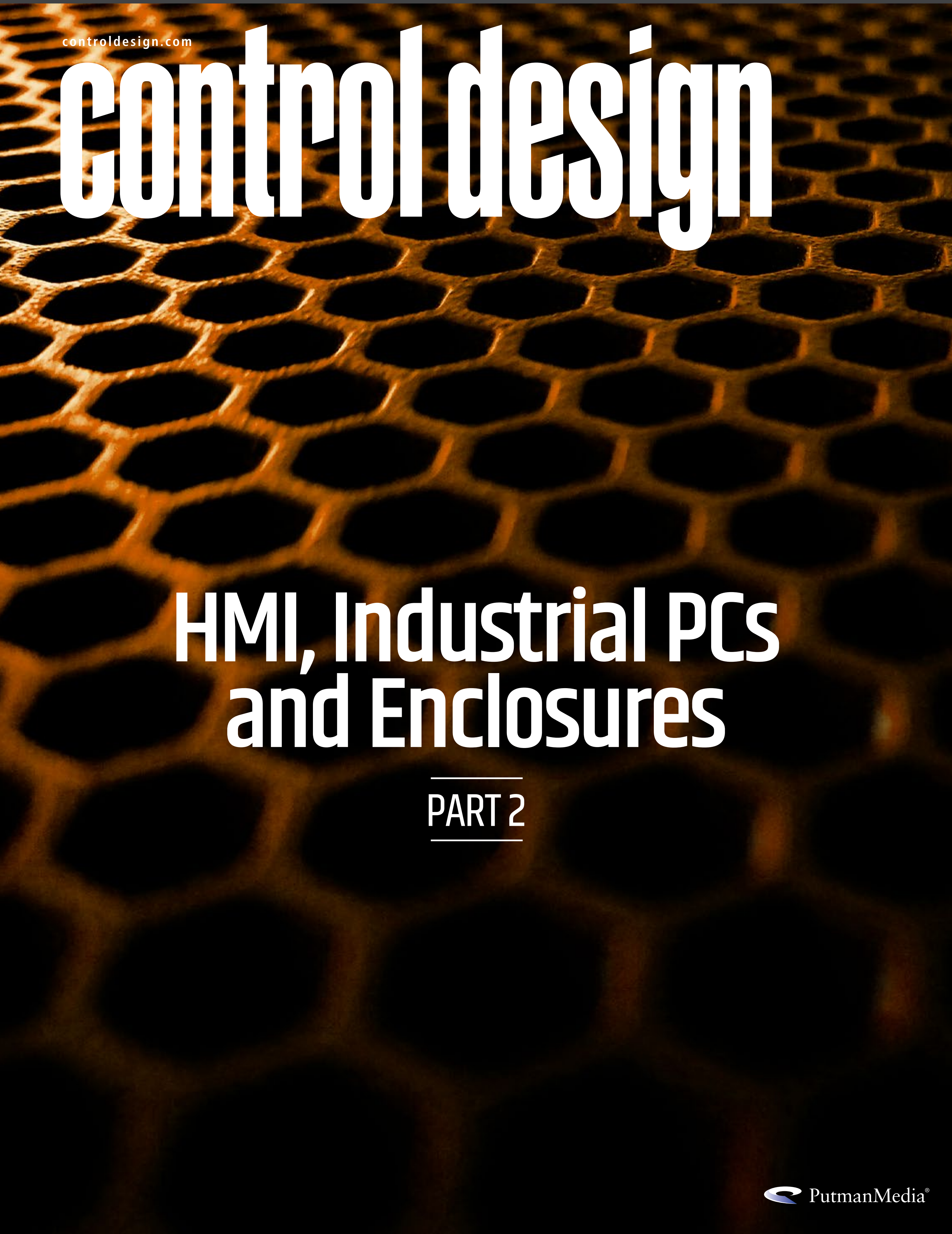

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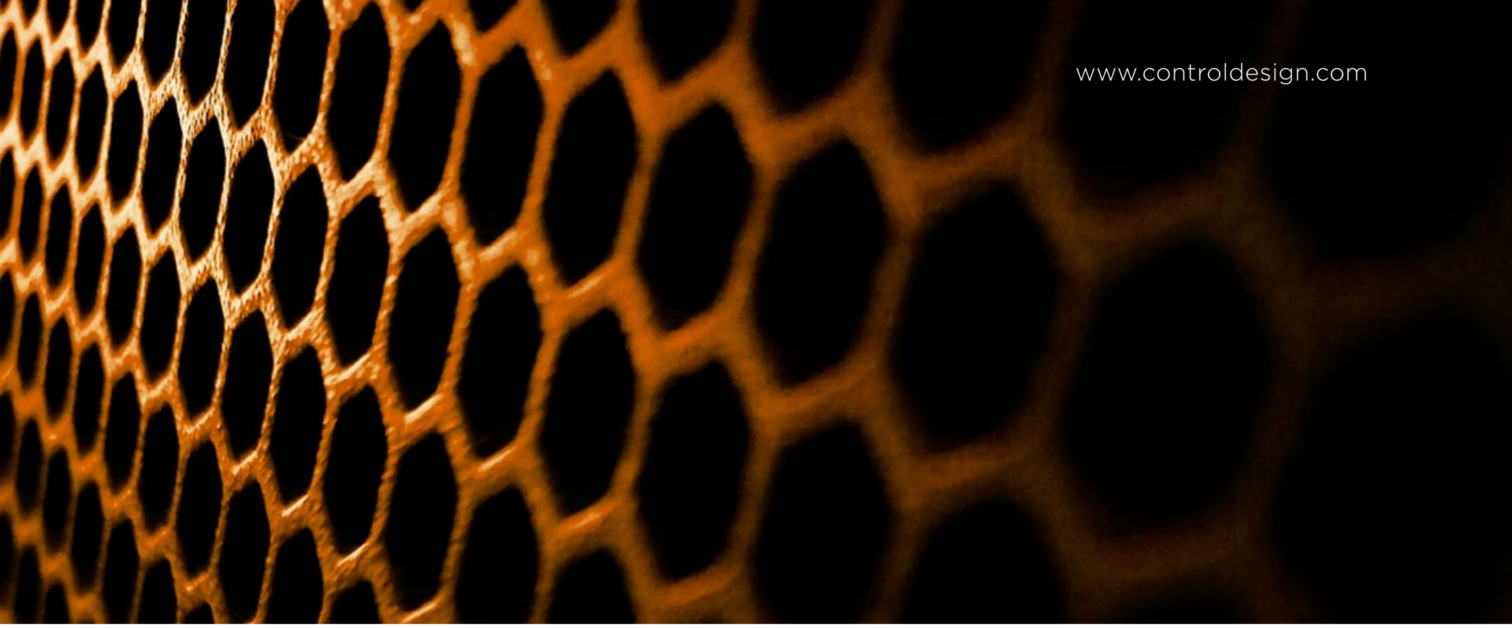

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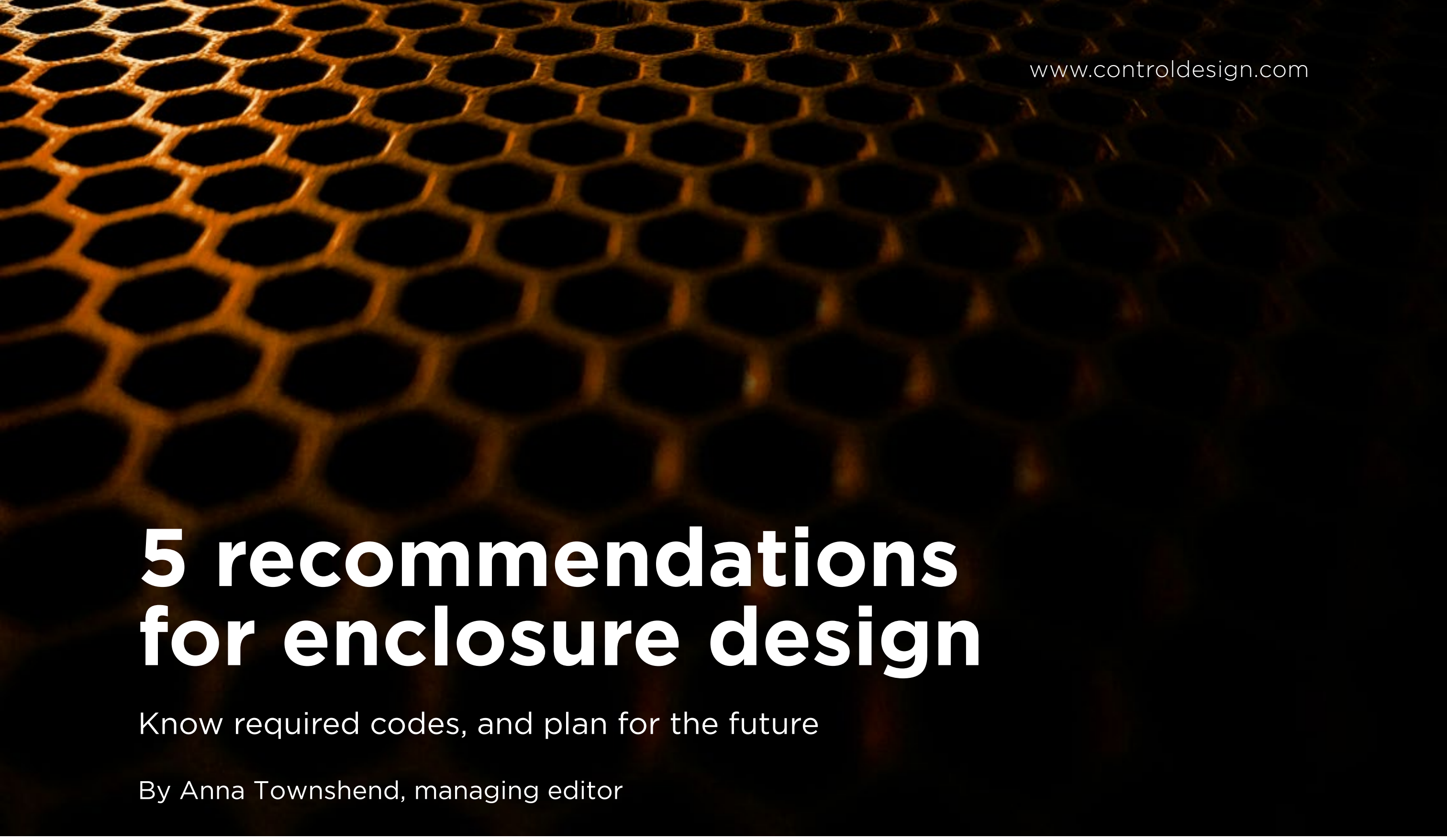


5 recommendations for enclosure design

Know required codes, and plan for the future

By Anna Townshend, managing editor

A Control Design reader writes: What are some of the key steps controls engineers should consider for main electrical enclosure design? Any recommendations on spare-space percentages in a junction box or main electrical enclosure? Is 20% a hard rule? What about key code areas in NEC and NFPA 79 to be aware of?

ANSWERS

FINAL INSTALLATION LOCATION AND APPLICATION

When it comes to main or any electrical enclosure design, a key step that surpasses all others is fully understanding the application and final location of use or installation (Figure 1). Based on this, it can be determined if there are standards that are good to follow or must be followed along with a product certification in order for the panel to be used and installed. Failure to understand all required standards and installation requirements will lead to a design that is at best not optimized, and in a worst-case scenario cannot be used. When it comes to specifics, it is best to consult with internal product compliance specialists within your company to determine which standards are applicable to the type of equipment being designed. If an internal expert is not available, seeking an external consultant that has knowledge of the requirements for your specific type of equipment can fulfil this requirement and get your design project started in the right direction.

From a generic, high-level standpoint, the final installation requirements are generally dictated by the National Electrical Code (NEC) or the National Fire Protection Agency (NFPA) 70 standard in the United States. This document will specify a number of items when it comes to installation requirements such as wire size, permitted equipment, spacings based on voltage and a number of other considerations for a proper and safe installation in a variety of settings and functions. When designing an industrial control panel or any electrical panel, it is important to assure that it can be installed properly, so consultation to the NEC is a general good starting point for quality panel design.

For a general consideration of an electrical or industrial control panel design, in addition to the considerations for proper installation, there are a number of product safety standards that could be consulted, especially if the design is to be listed or certified by a nationally recognized testing laboratory (NRTL). A good place to start is the scope of UL 508A. This is a generic industrial control panel design standard. The scope of this document lists various types of other panels that UL 508A would not cover. For example, portable control panels are covered by UL 1640, and termination boxes are covered by UL 1773. By reviewing the scope, you can determine if UL 508A would apply or if there is another, more specific standard that should be followed.

FINAL LOCATION
Figure 1: Most important for determining the required standards is the enclosure's final location and application.

Additionally, if the panel is specific for machinery control, standards such as the ANSI B11 series, NFPA 79 or a number of Occupational Safety and Health Administration (OSHA) requirements found in OSHA 29 CFR 1910 and CFR 1926 may also be applicable.

Finally, if the panel is involved with an installation that is tied to a hazardous or classified location that would fall within the installation requirements of Articles

500-506 in the NEC, these panels will need additional consideration and protection for use in these hazardous areas. Depending on the area of classification and the protection concept being used, standards such as UL 698A, UL 121201, UL 1203, UL 913 or those in the UL 60079 series will also need to be met.

Ryan Brownlee / global compliance and technology consultant / Pepperl+Fuchs / www.pepperl-fuchs.com/usa/en

Key code areas in NEC and NFPA 79:
- general operating conditions
- protection from electric shock
- protection of equipment
- grounding
- conductors and cables
- wiring practices
- marking and safety signs
- testing and verification.

Rob Brodecki / service product manager / Mitsubishi Electric Automation / www.mitsubishielectric.com

FUTURE EXPANSION NEEDS

At all points, designers need to consider not only the current scope of work from the customer and environmental and rating requirements, but also future expansion needs. So, 20% spare space is a good rule of thumb, but could be different depending on the type of application and customer.

One other thing to consider is the ongoing advances of machine connectivity and the Industrial Internet of Things (IIoT). Manufacturers may look to add new technologies to their equipment, and, while many of these are software-based, there is often the need to add in hardware to the control panel.

Key steps to consider for main electrical enclosure design:
- component selection
- enclosure type and size
- component layout
- safety and regulations.

KEY KNOWLEDGE AREAS

Control panel design requires knowledge in many key areas, such as codes. Hazardous-area considerations may define the type of protection required of the enclosure and/or the components mounted internally and/or HMI components mounted externally.

If you need to show evidence of a third-party certification to the municipal inspection authority and to the purchaser of the panel, the pertinent standards of that certification agency must be followed. For example, if the panel must be UL-approved, the pertinent UL standards must be followed. This may dictate the components that may be allowed.

The UL508A standard is the standard most of the municipal inspection authorities look for when cabinet designs are inspected. A panel ship can self-certify the cabinet design to UL 508A, if qualified. It must pass a test by UL to confirm knowledge of UL 508A.

For electrical considerations, follow the applicable codes (NFPA handbook) and UL standard when required for wire size, type and color or insulation, and fuses and circuit breakers.

Various methods for controlling the internal temperature can be utilized if necessary: selection of the exterior color, insulation, air purging, insulation, heater/thermostat, compressed air cooler, air conditioning, isolated thermal transfer with heatsink, sun shield and cabinet size. Thermal considerations include:

- the temperature rating of the items in the enclosure
- the heat output of those items
- the ambient conditions where the assembly will be installed.

Designers should have familiarity of various components. This comes with experience and involves knowing what types of components are acceptable for the sector you are selling to. Having knowledgeable vendors and distributors can be a big help. Important components include:
- enclosure
- wire ducts or guides
- wire markers
- terminal blocks
- fuses, circuit breakers
- HMI components.

Client's requirements can be identified with questions such as:
- Where it will be located?
- How will the client access it?
- Does it need a convenience outlet or internal lighting?
- From what direction(s) will the client run cabling or conduit?
- What are the wire, terminal and component labeling requirements?

Other space considerations, if not defined elsewhere, include:
- space needed between components
- space between component wiring terminals and wire ducts
- size of wire duct
- space to allow between cable entry and ducts or components
- space around the edge of the panel
- location of some components relative to others for ease of access, consideration for inter-wiring, grouping of signal types or other factors
- spare space recommendation of 15% to 25% for potential future device additions.

Michael Corwin / manager, customer support / Moore Industries / www.miinet.com

DESIGN MATURITY

Key steps for electrical enclosure design include the following:
- Use appropriate enclosure type rating for the environment it is located in, such as indoor, outdoor, corrosive, wet, dust, dirt and submersion in water.
- Type 1 enclosures can be fabricated following UL 508A guidelines; other en-

closure types are usually purchased and have an appropriate type rating. Alternatively, enclosures can be fabricated and tested for a particular type rating.
- Determine how the enclosure is to be mounted: wall, floor or pole.
- Heat calculation should be run to determine if the enclosure can dissipate the heat generated and not exceed the temperature rating of the components inside. Enclosure size can be increased if necessary, or climate control equipment may need to be added.
- Consult installation instructions of any component that generates heat. These instructions will define any required clearances to adjacent components which can affect enclosure size.

Recommendations on spare space percentages include these:
- In the case of industrial control cabinets, this is totally up to the designer/customer and depends on the likelihood of adding equipment to the cabinet in the future. Is the plant, machine or process design mature? The heat calculation should be considered. If the temperature of the cabinet is close to the maximum, consider not adding any spare space to prevent the addition of components that might add heat and exceed the maximum temperature.
- In the case of junction boxes, consult NEC, article 314.

Key code areas in NEC or NFPA 79 include:
- enough space for conductors
- room for bend radius for larger conductors
- room for any conductors running through enclosures
- room for part replacement and without being crowded
- touch safety, if any exposed electrical parts are greater than 50 Vac/60 Vdc
- NFPA 79 requirement of a print pocket.

Jim Gehenio / engineering manager, industry management & automation—automation solutions R&D/ Phoenix Contact / www.phoenixcontact.com

BOUNDARY CONDITIONS, SAFETY AND FUNCTION

In the main control panel, there are a lot of important issues to be considered, and all of them are relevant. If we must consider a sequence of points to be addressed, I would start by the boundary conditions that must be accomplished and are out of the control of the designer, followed by the safety aspects of the panel functional aspects—all of them extensively described in NFPA 79—and finally would consider the marking, tests and documentation of the panel.

Starting by the boundary conditions, normally they include the following:
- Maximum dimensions of the panel: limited by the available space where it will be placed and by the access to this place. Remember that the available room for the panel is probably the first question to be considered before starting any other action just because normally it is not under the control of the panel designer, it will

affect all the other steps, and it has actually the potential of making the design unfeasible.

- Mains supply voltage—three-phases, single phase or dc—will affect all selection of the protection circuits in the input of the panel and the disconnecting means of this panel. This topic is described in NFPA 79: 2021, chapters 5 to 7.
- The external environmental conditions and temperature are also important because those will define the protection type of the panel and the correct strategy of cooling and/or heating of this panel. The protection types are defined in NFPA79:2021, Chapter 11 with additional information in Annex F.

Discussing the safety aspects of the panel include these:

- Overcurrent protection, internal access to the panel, insulation of live parts, and all procedures related grounding and bonding of the panel are deeply discussed in NFPA 79: 2021, chapters 6 to 8 .
- It is also important a clear evaluation of the wiring, considering the temperature inside the panel and the limits defined by different loads, such as motor loads, different voltages on the cables, which must be separated, and the function of each cable—grounding, mains, control voltage. These aspects are discussed in NFPA 79: 2021, chapters 12 and 13.
- Finally the safety systems responsible for disconnection of the panel as a normal operation or in case of failure must receive special attention. They are described in NFPA 79:2021 79, chapters 5 and 7.

Regarding functional aspects, here we have the most of subjective points due the fact that most of them are more related to best practices in terms of assembly and operation of the panel:

- Spare space: It is always recommended to offer a minimum of 10%, reaching 30% if we can foresee an increasing of functionality of the panel for future updates. Regarding this point we always must consider that we already have solutions that allow the expansion of control points in a control panel without increase the footprint of the components.
- Temperature calculation: We have tools to give us the calculation of maximum reachable temperature inside the panel considering the power loss of the components, external temperature and panel size. We only must consider that, if there is spare space in this panel, the components that will fill this space in the future also can have some power loss; therefore, in the same way that we consider space spare, we also should consider spare power in our cooling system to keep the temperature of the panel at specified despite the inclusion of new devices.
- Power supplies selection: Most control panels need a stable control voltage that is supplied by a good quality power supply. One popular orientation is to not use more than 80% of the nominal current

The external environmental conditions and temperature are also important because those will define the protection type of the panel and the correct strategy of cooling and/or heating of this panel.

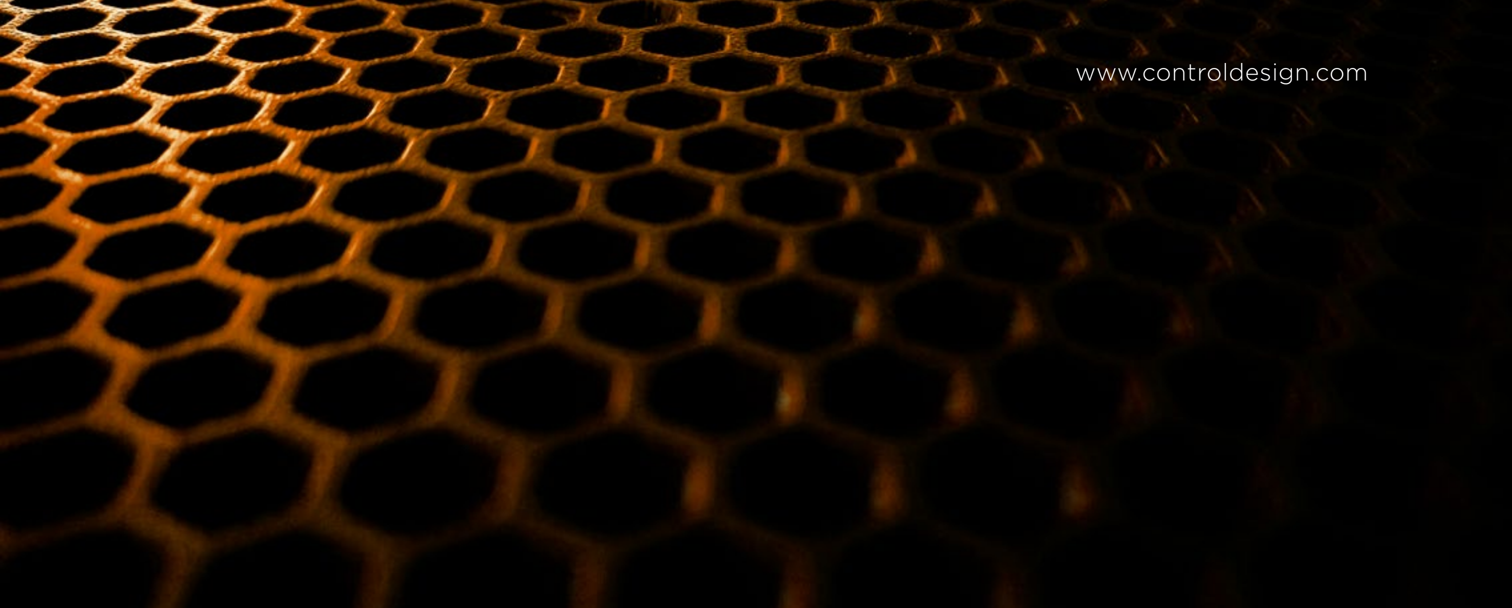
of the power supply. On one hand, it is valid considering future expansions and also considering that fluctuation in the load is common and can be supplied by this extra current; on the other hand, it is less relevant if the selected power supply already has a long-term power reserve that allows the power supply to work with spare also in nominal conditions. For wiring separation, the NFPA 79: 2021, Chapter 12, discusses the separation of wiring with different voltages, but there are other aspects also to be considered in terms of wiring routes inside the panel.

Testing, verification, marking and documentation include the following:

- The tests to confirm galvanic insulation of the panel and the tests to confirm the functionality and selectivity of the overcurrent protection and ground-fault circuit interruptor (GFCI) are basic parts of the process.
- Finally, the designer must consider that these panels, during their lifetime, will receive interventions of maintenance, which will only be possible with clear documentation and clear markings. The NFPA 79: 2021,Chapter 17, explains clearly the aspect-related documentation. The same standard in Chapter 16 presents the demand of marking, focusing in the signalization-related safety. It is important but certainly is not enough. Despite the quality of the documentation, the maintenance efforts will increase a lot if there is a lack of identification in the panel of each connection point, each wire and each device. Therefore, a good recommendation for a high-quality panel, despite all points above mentioned is to specify and use all the marking possible, for each device, each connection point and each end of cable, imagining that the markings will be used during the lifetime of this panel and must be visible during this time.

Reinaldo Cozzo / division head manager, APS / Weidmüller / www.weidmuller.com


Perforex



Vintage industrial PCs stand the test of time

By Jeremy Pollard, CET

IBM model number 5150 (the PC) was introduced on August 12, 1981. It would change our world as we knew it, although it would take some time to do so.

I had played around with microprocessors—Motorola 6800 and Intel MCS 8051, which the Allen-Bradley 1771-DB module was based on—in school, as well as with my good friend, Carl. He was a hardware wizard, and he was always fiddling with something.

He grew up fixing TVs of all sorts and knew his way around a tube amplifier like you and I walking around the block. You could imagine his excitement when the PC was introduced since he had migrated into software a wee bit.

The PC created a platform for creativity, and it was open, unlike Apple, which was very closed by design. I remember reading about arguments between Steve Jobs and Steve Wozniak about allowing openness, and Jobs won.

Kudos to IBM for publishing the PC for the world to enjoy.

Enter Dell Computer, Compaq, Gateway, and component-based companies, which broadened the PC format base in all spaces including the industrial space.

Carl, who was working for a power-tool manufacturer, decided to learn Lattice C and apply it to controls work and data grabbing from production lines using an Intel microprocessor 286-based personal computer. They worked well, and, as the technology improved, so did a vast array of applications that the PC could support.

Word processing and spreadsheets were the mainstay applications in business, but in the industrial world there were few applications that were being executed since most believed that a commercial product just couldn't stand up in the industrial environment.

In the beginning I would submit that an industrial computer was nothing more than commercially available components that were placed in a chassis with an oversized fan and a power supply that had some extra filtering in it. The motherboards and memory chips were standard fare. Based on failures it became clear that some additional work needed to be done in industrial computer design.

IBM was, in the beginning, a leader in industrial designs. Believe it or not, I still have a technical manual for the IBM 7531/32 industrial computer. Inside this manual is a comparison between the normal PC and the industrialized version—minuscule differences, but enough to tank your assembler program if you used the wrong operation codes (opcodes).

It was based on the Intel 286 microprocessor and had the ability to accept expansion cards such as extended/expanded memory modules.

PC industrial-based products were available in various formats. Virtual machine environment (VME) bus systems, as well as PC-104 embedded solutions, could be applied in many different applications but weren't "open," as such. A very specific skill set was needed to utilize these hardware platforms.

The IBM 7531/32 industrial computer changed the way we thought about using commercialized hardware on the factory floor. Windows 2.1 was available, as was QuickBasic, which allowed the control engineer to write and implement solutions for his/her own use. It was a sort of renaissance for the industrial user.

PLC programming software had been available for some time and was based on DOS. Industrial laptops were just becoming visible. And they weren't cheap. But now the plant-floor electrician had a tool that could be used on the floor and didn't weigh 35 lb, which earlier programming units did.

And we have never looked back. There is a big argument that has raged on forever about why you need to use industrial gear for industrial use. According to Thomas Register there are 656 suppliers of industrial computer hardware, so there must be something to this argument.

Part of the difference is found in the electronics used in the systems—0 to 60 ºC is a standard for industrial systems in the early days. This specification applied to all components.

This specification can vary based on the components used. Most industrial subassemblies would use military-specification components, and, with the level of integration in modern-day appliances, the temperature specifications are important to be aware of.

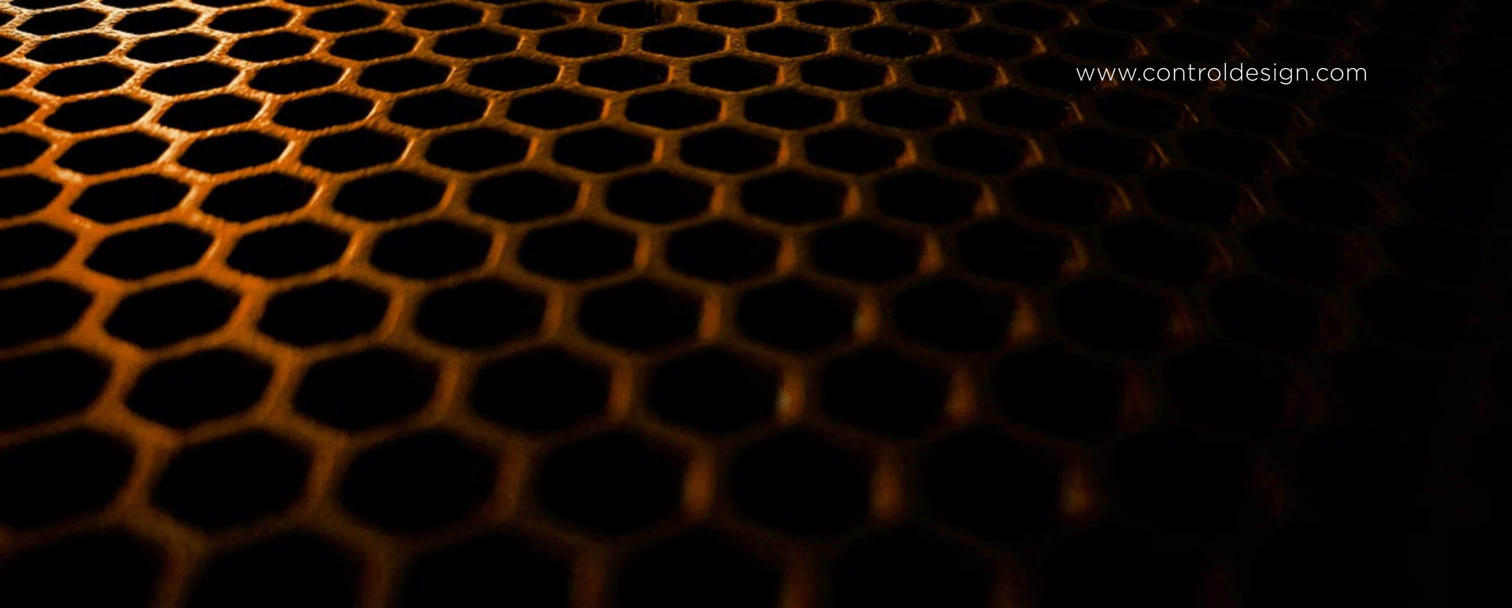
Shock and vibration specifications for industrial computers along with power filtering and cooling set these computers apart from the normal desktop variety.

The advent of fanless designs accentuates the maintainability of these computers. If a fan fails, then the internal temperature would increase, causing failure of one or more of the components. In a commercially available computer, there are multiple fans to keep things cool.

A fanless design rocks.

You will pay more for an industrial design and build. And there are good reasons for that. For any application that will be living in the industrial world it would behoove the designer to err on the side of longevity and choose from the array of solutions that will benefit the implementation for a long time to come.

The IBM 7531 still lives, by the way. It is considered vintage though.



The transformation of HMIs

HMIs are evolving from simple interfaces into open communication platforms

By Anna Townshend

HMIs once served the sole purpose of interfacing at the machine level, with each application using its own software, which communicates between devices. Now, in some cases, the human-machine interface (HMI) is taking on a larger role, led by the need for more computing power and real-time analytics, as well as the introduction of Web-based software technologies into industrial manufacturing. This is creating a much more open environment, powering better remote access, data manipulation and edge computing from the HMI. Innovative HMI offerings from seven companies—Idec (us.idec.com), ADISRA (www.adisra.com), Beijer Electronics (www.beijerelectronics.com), Omron Automation Americas (automation.comron.com), Phoenix Contact (www.phoenixcontact.com), Bosch Rexroth (www.boschrexroth.com), and Siemens (www.siemens.com)—offer a variety of features, including Web-based technology, open platforms, high performance computing and advanced database analysis.

TWO-WAY REMOTE ACCESS

Idec's HG series HMIs range from 4.3 to 15 inches and are configured using WindO/I-NV4 screen creation software, which Linda Htay, product marketing specialist for Idec (us.idec.com), calls "simple and intuitive." She says the HMIs are designed for all types of end users. Because the HMIs are suited for harsh conditions, the oil and gas industry is a main market for this product, including many others, such as packaging, medical equipment, wastewater treatment and traffic control and transportation.

FUTURE-PROOF ACCESS
Figure 1: The HMI HG series includes a built-in web server to facilitate remote monitoring and control.

Due to the pandemic, demands for HMIs that can withstand disinfecting and sanitizing equipment has risen, says Htay.

The HMIs are built to support a wide range of operating temperatures, from -20 °F to 60 °F for outdoor mounting. The screen also includes long-lasting LED lights, rated for 100,000 hours or more to minimize service needs. The liquid-crystal display (LCD) uses thin-film-transistor (TFT) technology, which makes the display brighter and sharper.

"The TFT technology provides certain benefits to improve HMI image quality," Htay says. The TFT refreshes more quickly than a regular LCD display, she adds. The display is also readable in harsh or very bright lighting. "The brightness is the key feature to enable the HMI to be sunlight-readable," Htay says.

The Idec HMI includes a built-in web server to facilitate remote monitoring and control with cybersecurity features (Figure 1). "The HMI web server is accessed using any device with a web browser, such as a smartphone, tablet or PC. Accessing the HMI using this method gives a user the same functionality, as if they were standing in front of the HMI on the factory floor," Htay says.

It makes troubleshooting and system maintenance possible anytime from anywhere. Control limitations and the monitoring functions available to a remote user should be considered for proper cybersecurity of critical applications, notes Htay.

"The typical network configuration of HMIs with servers includes a local network with Ethernet communication and suitable industrial protocol. The HMI connects to controllers and to both local and remote web-browser terminals. The web browser on external networks accesses the HMI on the local network through the local network's gateway/router and firewall, again following proper cybersecurity practices," Htay says. "The user-account security function can give users multiple-level access to machines or equipment, based on their priority level."

DATA CONNECTIVITY

Figure 2: SmartView is an HMI, SCADA and IIoT development environment and can connect to proprietary drivers or with older communication options.

Two-way access to the HMIs via Wi-Fi Ethernet is provided through mobile apps for Android and iOS devices. "Users can download and upload programming, or they can delete data from the internal memory or an external memory device, such as a USB flash or microSD card," Htay says. "Since the app can do it wirelessly, there's no need to make sure the right cabling or program or software is available."

Technicians can access the HMI of a PLC without even opening the cabinet. The app also includes features to limit the parameters that are being monitored and controlled. The HMI, using a file-transfer-protocol (FTP) function or mobile app or both, can read and write—copy or move—files to local memory, an external memory device or a cloud-based file, database or data storage platform. "This gives users even more options," Htay says.

The mobile app also provides some data configuration. The logged data can be viewed in a trend graph, as well as attached to a text message or email and sent using templates configured for multiple recipients. Alarm logs, data logs, operation logos and screen shots can also be captured and sent this way, so, if errors occur, management is notified right away. "It helps the user to increase productivity and minimize downtime of the applications," Htay says.

COMPREHENSIVE DEVELOPMENT ENVIRONMENT

Marcia Gadbois, president and general manager of ADISRA (www.adisra.com), has seen a recent evolution in HMI development and equipment. "It used to be the HMI was just in the machine, and it did a very dedicated thing. Now it has evolved to not only do that, because that's still a purpose that it serves, but it's also offering machine builders the ability to transform their model by doing remote viewing and servicing of their machines remotely. It's also now being put into headless devices, so it can do not only remote visualization, but the analytics, as well," Gadbois says.

ADISRA's software offering SmartView captures this next evolution of HMI software, she says. The connectivity between HMIs and sensors, PLCs and controllers, and all the sources of data and all the historical data, Gadbois says, gives the applications quicker access to that data in real time, and the system can perform anomaly detection to act on that data. “It should be able to not only do a decision tree, but analytics on the data that’s coming in in real time, and say there’s a problem based on casual analysis,” Gadbois says. “So, it’s reading it in real time and giving analytical suggestions based on the data and history.”

SmartView is an HMI, SCADA and IIoT development environment, and it also includes built-in redundancy (Figure 2). “It is allowing you built-in protection for downtime, so if something goes down, the other system picks up the load of continuing to analyze the data, and then, when the other HMI or edge device comes back online, it will sync it,” Gadbois says.

ADISRA is a big fan of OPC UA, she says, because of all the connectivity choices there, but SmartView can connect to proprietary drivers or with older communication options. “You have to work with the IT, as well as work with the proprietary, older protocols, as well as providing them a bridge to the new one,” Gadbois says.

SmartView extends HMI connectivity to all types of intelligent IIoT sensors, databases, historians, the cloud and other systems. “In classic automation architectures, there is a distinct site-centric HMI layer and a separate enterprise-centric analytic layer, so information and recommendations between the two must constantly be communicated, creating inefficiencies,” Gadbois says.

SmartView combines a comprehensive development environment for mobile, edge, dedicated hardware, personal computer and cloud environments into one platform.

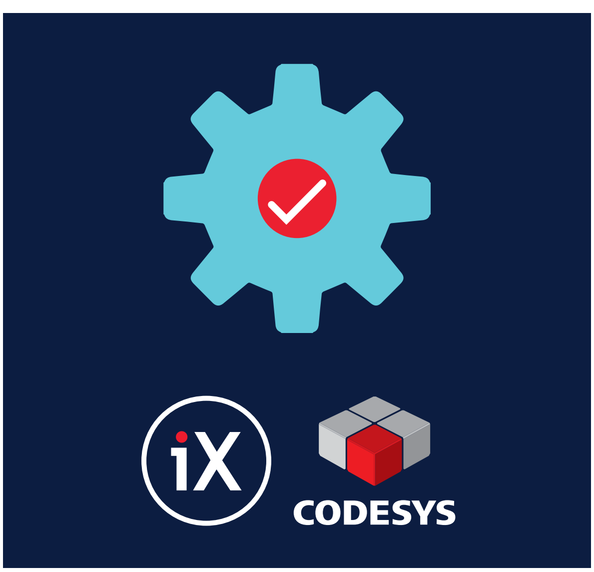
SmartView is also SCADA-ready. “It has all the functionality for the SCADA market, as well as HMI,” Gadbois says. “It really is combining all that into one package.” With a small footprint, she says, it serves the IIoT market and many devices.
The HMI can reside with headless sensors or edge devices. “What it’s really doing there is it allows you to do remote visualization of the data coming in, but it is also helping you to understand what that data means as it’s coming in,” Gadbois says.

This HMI is applicable across many industries. As a company, Gadbois says, ADISRA has been focused largely on small to mid-sized manufacturers. The software has been used in oil and gas, water and wastewater and other industries. “Our focus is machine builders, the OEM market and small to mid-sized manufactures,” Gadbois says. For the small to mid-sized manufacturers, she thinks they are underserved by the current marketplace.

SOFTWARE DEVELOPMENT À LA CARTE

Jeff Hayes, product manager at Beijer Electronics (www.beijerelectronics.com), has also seen a move in HMI software development toward more connectivity and openness, and he also detailed how software has become the more valuable product for companies. “Hardware has become almost a commodity in HMIs,” Hayes says. “For the most part, for internal machines, HMI hardware is standard, so where companies spend their engineering resources and expenses is in software development.”

Beijer uses its own proprietary software, iX Developer, which is a GUI-like tool. At the company, the development group works closely with the support team and product managers to create custom products that customers are asking for in the field. Those products were shared internally for use with other customers, and Hayes says, that was the unofficial start to the Smart Engineering Resources (SMEs). Eventually, Beijer formally packaged the custom products and put them on a website for the public (Figure 3). These pieces of code for different applications are available, some for free and some for sale, to download and use with Beijer’s proprietary software. The project has grown since its inception, and Biejer actively creates the packages and publishes one or two per week. The package may include some how-to text on implementing the code, and Beijer’s customer-service department is available to help any user to implement new software.



RESOURCE LIBRARY
Figure 3: Smart Engineering Resources began as custom products designed in the field for customers, now available to the public.

Adding PLC software to the HMI is a growing trend, Hayes says, which is supported by one of its SMEs. “Instead of having separate PLC and HMI hardware, you do it together in one machine in one HMI,” Hayes says. He uses smartphones as an analogy. “A smartphone used to be just a phone, and you had a separate MP3 player and separate GPS, and they’ve added everything together into one device. The same thing can be said with HMIs today. We’re doing a lot more with them,” he says.

A lot of HMIs use CODESYS, which is an open-source product. How to access and use that CODESYS software with a PLC is another example of a use of Smart Engineering Resources.

One of the latest resources available gives users more options to analyze data. "We gather an awful lot of data from the PLCs, and, so, what do we do with that data? What people want to do is they want to be able to make business decisions with that data," Hayes says.

The information collected can be easily displayed on a dashboard. "We have integrated our software with Excel and Microsoft Power BI software, so we give you the data dump, and you can use whatever software to aggregate and parse the data and create dashboards from the data," Hayes says.

The use of Smart Engineering Resources does require a novice-level knowledge of the software. "We try to make our software easy to use because it's a graphical interface for the basics," Hayes says. But underlying the graphical interface is the .net Microsoft framework, which uses C# (C-sharp) programming. "Most of the people that will use our product will have developed a pretty good understanding of C# and the programming involved with it," Hayes says.

INTEGRATED DEVELOPMENT ENVIRONMENT

Data manipulation was on developers' minds at Omron, when it created its Soft NA runtime software, says Clark Kromenaker, product manager of HMI, IPC, controllers and software for Omron Automation Americas (automation.omron.com). Kromenaker also points to other software development trends. "I think what I've seen change is a move toward an integrated development environment (IDE)," he says.

In a more traditional setup, the HMI and the PLC each had separate development programs, as well as all the individual devices in the application. When considering software updates, or firmware updates for the HMI itself or the PLC, it can be cumbersome to do all that, at least quickly, Kromenaker says.

"So, what a lot of developers are going to is what's known as an integrated development environment, where one software tool, Sysmac Studio, has all those development environments in one software package, so they can program the PLC, the HMI, safety, motion, everything off one development environment," Kromenaker says. Updates can be done once, and each device gets updated at the same time, he says.

In general, Kromenaker says, HMI screens are trending larger and higher resolution. "A lot of that follows consumer trends," he says. The objects that are used in developing the HMI application are becoming more sophisticated. "Instead of push buttons and indicator lights and gauges, more advanced data manipulation tools can visualize data more effectively," he says.

Soft NA was released in spring 2020. "It's an emulator for another product that is hardware-based," Kromenaker says. The Omron hardware-based HMI, called NA5, is a closed-loop system with computer components but not a full-blown computer. "The user can only do one thing with it, and that's to run an HMI interface on it," he says. "So, we developed an emulator that emulates all the functionality of that hardware version, NA5." An industrial PC can run Soft NA and enterprise resource planning software or manufacturer enterprise software, along with controlling the machine itself through the Soft NA, Kromenaker says.

"The main driver for developing that was data manipulation," he says. The reams of data coming off the factory line need a computer to manage all that data. "A PLC is great at running machines, but it does not do a very good job if you're trying to manipulate data in a PLC," Kromenaker says.

With Soft NA, users can also choose the computer power they want (Figure 4). "In the hardware version, NA5, you're limited completely to what the design is of the product. With Soft NA, you could choose any type of processor, CPU, any amount of memory, hard drive size," Kromenaker says.

COMPUTING POWER

Figure 4: With Soft NA, users can choose the computer power they want, and those that need high-performance can store and process large amounts of data.

Users of Soft NA need the high-performance computing power to process and store large amounts of data. "Almost every manufacturer is becoming more information-intensive, but, for this type of power, particularly in food and pharmaceutical, they are required to collect a lot of manufacturing data," Kromenaker said. Data on raw materials and operators working at a machine can assist if problems occur and recalls are needed.

The automotive industry also has large data needs, Kromenaker says. Serialized components and conditions are monitored for trends; for instance, spikes in temperature are usually a sign of an issue. "Things like that help to have a continuously functioning operation, where you're not surprised by downtime," Kromenaker says. By monitoring trends, operators can know when service is needed before breakdowns and schedule that maintenance during holidays or breaks, or before it causes downtime.

Soft NA, as part of the Sysmac solution, was designed to interface as an HMI to Omron's NJ and NX series of machine automation controllers, and applications that are developed on Soft NA will also run on NA5, so it's portable between both the two platforms. "Machine builders using the NA5 can now add an option to upgrade to a Soft NA and IPC HMI, where other software can also be used to provide more functionality at the machine level," Kromenaker says.

OPEN COMMUNICATION
Figure 5: The BWP2000/WP4000 series HTML5 web panel can talk to any web server for visualization.

UNIVERSAL WEB-BASED PROTOCOL

HMI software development is also moving away entirely from traditional runtime setups and instead using web-based protocols for easier communication. In a more traditional HMI setup, users create the visualization project at the HMI. "The visualization resides on the operator panel," says Bjoern Falke, product manager for HMI/IPC for Phoenix Contact (www.phoenixcontact.com).

If that operator panel gets damaged and needs to be replaced, that's at least a two-step process, Falke says. Users have to replace the damaged hardware, and find the visualization project associated with that station and download it to the unit. "If you do good housekeeping, and you keep these projects neatly organized, it shouldn't be a problem, but it is a little more involved," Falke says.

The Phoenix Contact BWP2000/WP4000 series HTML5 web panel is making that process easier. The web panel can talk to any web server for visualization of PLC data or any kind of visualization, configuration or diagnostic data hosted by a web server (Figure 5).

"The HMI projects no longer reside on the HTML5 web panel," Falke says. "Because we are able to utilize the universal HTML5 protocol, we can talk to any kind of web service, so you're no longer tied to any specific manufacturer."

If the unit were ever to get damaged, users can replace the web panel, and all they need is the IP address of the web server.

"That should hopefully be on the label of the unit, if you do good housekeeping," Falke says. "So, you don't have to chase down that HMI project anymore because that HMI project would reside on the web server."

The web panels are the next step in the evolution of the HMI, he explains. "It's definitely closer to IIoT because you are now more open. You are more universal, and the whole deployment is easier because the HMI now grabs the data that it needs to display from a centrally located web server," Falke says.

A few years ago, Phoenix Contact launched a new series of PLCs with a built-in web server. This product was designed to work with that web-based device, but it also allows for compatibility with a much larger number of applications.

With HTML5, the web panel doesn't need Ethernet IP, Profinet or Modbus TCP compatibility or any vendor-specific protocol to communicate. With no local HMI project to download, the panels are quicker to deploy in new machines and service if damaged. "You have the luxury of reduced downtime in your installation and quicker deployment," Falke says.

Web-based systems are being used in many industries. The traditional sectors, Falke says, are automotive and material handling, but the web panel has also been used in oil and gas, agricultural and water monitoring applications.

ON THE EDGE

"HTML5 technology has existed for some time as a web technology for building web pages that we all use every day, but it has been slower to enter the industrial machine controls," says Allen Tubbs, product manager at Bosch Rexroth (www.boschrexroth.com). "The growth of technology outside of manufacturing has allowed us to pull those types of solutions into industrial manufacturing."

With Bosch Rexroth's runtime visualization software called WinStudio, Tubbs says, it made sense for the company to rethink its HMI strategy. Now, Bosch Rexroth will also offer WebIQ, its fully HTML5 based solution, as part of its ctrlX Automation platform. It's been released as a prototype version, and the full version will be available to the public in April 2021. The WebIQ product is made by German-based company Smart HMI, and fits in the Rexroth's open ctrlX architecture.

"Web servers allow the use of almost any device with a browser to view the application," Tubbs says. "Also, HMI software is becoming more open to third-party solutions integration that allows for more implementation on the IT side." Open-source and third-party software solutions that have not been focused on industrial manufacturing, are now bringing simple-to-implement solutions, such as edge databases, data visualization and SMS texting to the HMI.

Traditional HMI software designs have typically used what-you-see-is-what-you-get (WYSIWYG) editors, which allow users to drag interface objects onto a screen that will appear later as the runtime application. Similar tools are used by the web-design community in applications that help users to build web pages quickly, and WebIQ brings the WYSIWYG design tool to the HTML5 environment. “Traditional WYSIWYG editors do not typically have HTML5-type solutions. It has been an either/or choice until recently,” Tubbs says.

Many HMI applications have long been able to record, store and perform simple trend analyses on the data, but WebIQ allows for more sophisticated analysis tools, such as databases, integrated alongside the visualization piece (Figure 6).

“Simply having the advanced query capability of a database at the edge is quite valuable in analyzing machine data. Traditional HMI software has had the ability to record data and even visualize it, but has not had the power of a true database,” Tubbs says. “As software technology grows, the HMI, as a user interface is progressively being pushed to be an edge-compute device as well.”

ADVANCED QUERY DATABASE
Figure 6: The WebIQ, an HTML5-based solution, facilitates advanced query capabilities at the edge.

Perhaps always an edge device by definition, the HMI has not always had the IT communication and processing capability that machines have today and which allows for the use of HMIs as more than simple interfaces. “The merging of IT software into the OT space is allowing for more capabilities on the PCs that were typically only used for machine communication and operator interface. Now, data can be collected and analyzed at the machine with database and machine-learning tools,” Tubbs says.

Previously, with proprietary systems, users could run the HMI software but nothing else. “The hardware was pretty much designed around the software,” Tubbs says. “But now as software has become more independent from the hardware, now you can run the software on lots of different types of hardware and design the system such that you can add other functions into it.”

As a recent example, Tubbs says, the WebIQ software was integrated with an InfluxDB database into the same PC that's running WebIQ. InfluxDB, an open-source time series database, stores the machine data. "Not only can we do visualization on the data like we could before, but I can use a query engine from InfluxDB to be able to pull insight out of that data and keep all that data right there on the edge without having to send it to a network database or a cloud database," Tubbs says.

With the blending of web page functions, the application can be deployed simultaneously on many different hardware platforms. The software license structure can be modified to meet the specific application size.

"The cost of the system is based on the scale of functionality, and there are different types of functions that are unlockable along the way," Tubbs says. "That's a typical way of scaling HMIs in the past."

However, the WebIQ software also provides another way to scale. "You have users that want to connect into the system from the top down, rather than from the machine up, so you can also scale based on how many clients need access at the same time," Tubbs says.

BREAKING DOWN SOFTWARE BARRIERS
Figure 7: WinCC Unified visualization software's open interface can take the power of an IPC and put it in a panel at the machine.

FROM SINGLE MACHINE TO SCADA

Siemens has also embraced web-based technology with its new visualization software system, Simatic WinCC Unified. "The software runs on a variety of platforms, from proprietary panels to PCs, and users can interact with the machine directly from this platform or from a network-connected client, such as a smartphone or tablet," says Ramey Miller, HMI product manager for the United States at Siemens (www.siemens.com). "It's really breaking down a lot of barriers between functionality that would be typically pigeon-holed into an IPC or a PC terminal, where it would reside in a powerful system there. We've broken the barrier down of software functionalities and pulled those into a panel-built machine-level solution (Figure 7)." From a single machine on the facility floor, multiple isolated systems can share data and screens, and as the network grows, the WinCC Unified system will take users all the way to a SCADA system.

"The open communication is definitely a focus point right now because everybody wants to have remote access," Miller says. "The backbone is developed with openness in mind to allow porting of information out." The native drive technologies needed to communicate with other systems are all built into WinCC Unified.

The use of scalable vector graphics (SVGs) helps to make the transfer between devices quick and seamless. SVGs are a standard of graphics that can be resized without loss of image quality or resolution. With a bitmap or a .jpg file that's imported into an HMI screen, if a user sized the project for a 7-inch screen and then tried to view that project on a 15-inch screen, the image would pixelate. SVGs can scale from any size and keep a clean, crisp image.

"It lends itself to be more flexible for all this remote connectivity that we've been building up. You're not set to just the resolution of the operation terminal anymore," Miller says.

WinCC Unified is built to integrate with Siemens Totally Integrated Automation Portal (TIA Portal), the encapsulating software that runs other Siemens products.

For instance, users can get tag information from a separate PLC very easily into the HMI within the same project because the two devices are already aware of each other. "They can easily relate and connect diagnostics information or alarm information," Miller says.

The software also allows users to reuse elements across different hardware and projects, saving time and money to deploy to an unlimited number of panels and PC systems. "Having a panel and a PC runtime software package that can handle both types of solutions, the objects that you develop for configuring within a project can now do tasks between those two different platforms," Miller says.

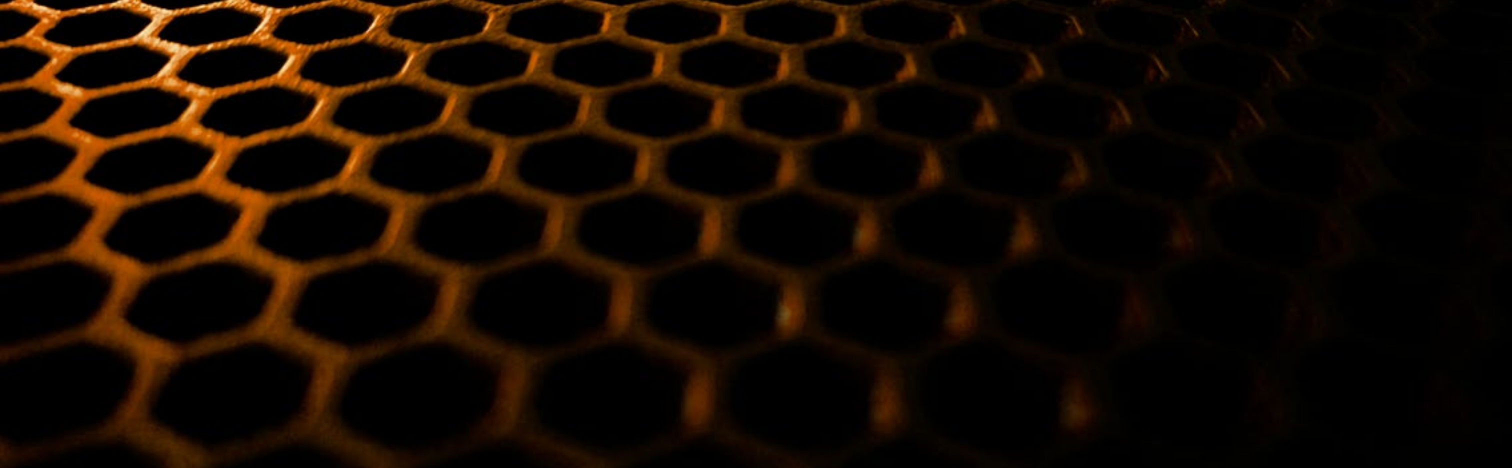
"You're not going to have to redesign that entire graphical object and how it works. All of that is easily pushed and pulled back and forth between those two platforms," says Miller.

From a graphical standpoint, objects are known and configured the same between the platforms, Miller says. "That's part of the scalability. We can easily change our device type to any screen size of the panels, and it will reset that project to run on that different size panel," he says.

WinCC Unified also works natively with web technologies such as HTML5 and others. "The software provides a wide range of industry-specific offerings, and it can be customized for user-specific applications with its open interfaces," Miller says.

It also supports multiple communication protocols and can exchange data with other systems. "That makes it very flexible from a human-machine-interface aspect, to connect to devices that are not necessarily from Siemens," he says. "The newer architecture that we're seeing is remote access. People want to drill down the machine screens from anywhere in the facility, and you can do that with the web-based technology that it's built on."

Siemens is also looking at the future of HMIs and software integration, Miller says. "They may not be out on the factory floor yet, but we see future cases of augmented or virtual reality-type interfacing with our system," he says. WinCC Unified is set up with the foundation to realize those advances in the near future.



HMI software doing more at home

From machine control to data processing at the edge, more HMIs are more than a simple interface

HMI Software has come a long way in the past 30 years. Or has it? We are monitoring the same systems and need the same interface as we did back then. So, where are the differences?

I tried to come up with a list of disparate items but came up short since the changes in HMI software that are coming may take some time to become embedded in standard HMI interfaces.

There is a trend to have the HMI integrated into the control hardware. Unitronics has merged its PLC offering with its HMI software to create an all-in-one, one-size-fits-all controller.

Opto 22's edge programmable industrial controller (EPIC) has Inductive Automation's Ignition built-in, but you need a separate license for it, which is understandable. However, Opto 22's standard HMI interface is available at no extra cost. The touch screen interface also acts as a troubleshooting tool for the attached hardware, which is a very cool feature for edge type controllers.

The Rockwell Automation ControlLogix/CompactLogix has the capability for multiple operating systems. That means Windows could be mounted in one of the sessions that could run the HMI software, such as FactoryTalk ME/SE. All that would be needed is a monitor and operator interface facilities, such as a touch screen and/or keyboard.

HMI software for machine control is localized to the controlled process, and because of that it needs to have the right array of objects and dynamic data to allow the operator, if there is one, to operate the process. This is where the lines between HMI and SCADA blur a bit.

Data historians are required to have historical trending, which can go back hours/days/weeks. Standard HMI trending will allow for a certain amount of history, but if the machine is a lights-out process, you may want to add a trending program/historian, such as Canary Labs, to the mix if you can.

Fixed HMIs run on their own operating systems, so adding third-party software may not be an option; it's best to understand your needs before implementing the solution.

One component of HMI software that has started to garner some attention is the ability to process data at the edge. This requires that the HMI/controller combination should support additional protocols, such as MQTT. MQTT is a very lightweight network messaging protocol that allows for data to be sent between two locations. The reason for its popularity is that it can be used very effectively over low-bandwidth network connections and over data-driven networks such as cellular. This can keep costs down.

Another trend in the HMI space is the need for the HMI to process data, like a SCADA system does, as well as the ability to push this processed data to the cloud directly. This suggests that the HMI must be on the OT network, which infers Ethernet connectivity. This is very commonplace in control strategy.

One of the newcomers on the HMI scene is ADISRA, from the founder of InduSoft, which was sold to Invensys in 2013. ADISRA stands for aware, diverse, integrated, self-regulated and adaptive. It intends to be the answer to any of your HMI questions including Industry 4.0 and IIoT.

The ability to use MQTT allows ADISRA to connect processed data to the cloud directly. I would suggest that all HMI software will engage in this behavior as time moves on.

One trend that I cannot wrap my head around is accessing the main HMI screens using a mobile phone. Screen real estate is at such a premium with complex applications that the usefulness of a 6-inch screen is questionable.

The other trend that I find hard to consider is remote access using your mobile device. Security is the issue here. Even a flashlight application can provide a problematic response with your device.

Enter Suppanel—an android application to create HMI supervisory panels. It can use Ethernet/IP, OPC, Modbus TCP or Siemens Step 7 protocols to communicate to a con-

One component of HMI software that has started to garner some attention is the ability to process data at the edge.

trolling device. Again, security is a possible issue here, but to be fair I have not installed, used and reviewed the product, but I find that with a device that is dedicated to an HMI application I really don't have any issues with it. With a personal device however with various apps and games installed, I think it is a case of user beware.

Having alarming being pushed to a mobile device can be very useful. Location services may be useful as well since certain alarms could be pushed to the device(s) in the area instead of to all in the list.

Call me old-fashioned, but I need a big screen to have a basic overview of the process. The attraction of mobility however is a very valid posture.

We have an exciting HMI future ahead of us. Let us be ready.

Some assembly required:

Flexible controls enable building-block approach to machine design

AZCO realizes modular converting machine concept through the flexibility of EtherCAT and PC-based control

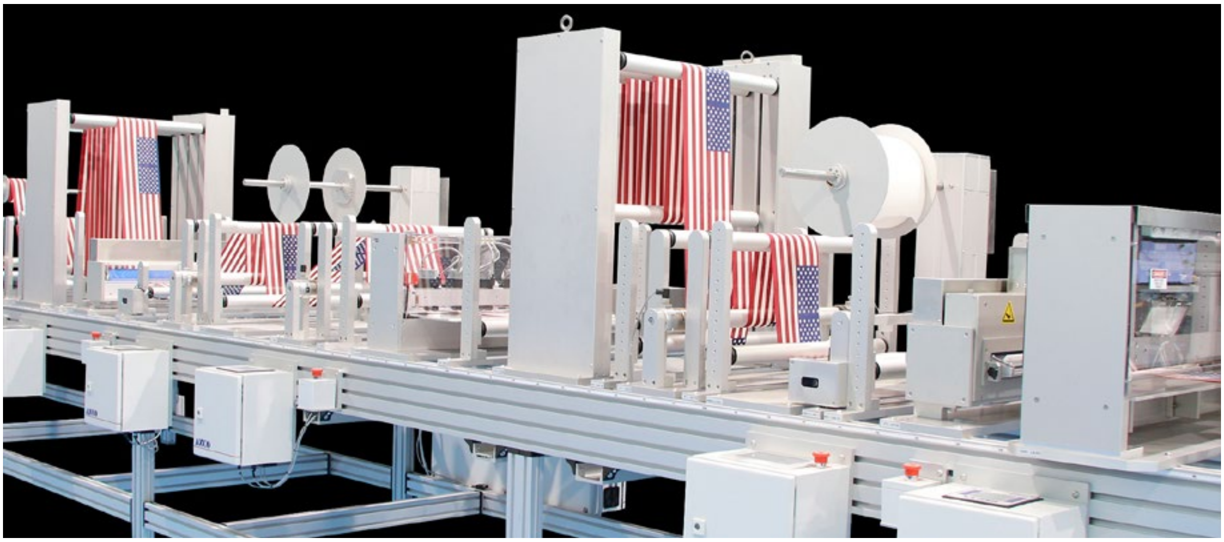
By Margie McKeon, AZCO

Flexibility has been central to AZCO (www.azcocorp.com) since its inception. President Andy Zucaro started the company in his basement 37 years ago with a pencil and a drawing board propped on two cabinets.

Through innovation in custom machine design, the company grew steadily and now employs 35 people. It serves a range of customers from startups to Fortune 100 companies, primarily in the United States in medical-device manufacturing, converting and packaging, as well as machine builders that serve these markets.

AZCO carved out a niche in feeding, cutting and placing flexible materials, offering numerous modules that can be integrated into the process (Figure 1). With the Building Blocks of Automation, AZCO delivers modular machines that allow end users to minimize engineering efforts and perform rapid

FUNCTION-RICH MODULES
Figure 1: The Building Blocks of Automation from AZCO offers a variety of standard modules for rolling, laminating, cutting and other functions to suit end users' unique requirements. (Source: AZCO)



EXTREME FLEXIBILITY

Figure 2: AZCO's modular Building Blocks of Automation concept provides extreme flexibility in the initial design and when reconfiguring machines for new materials and processes. (Source: AZCO)

changeovers to meet evolving consumer demands (Figure 2).

"Our whole purpose is to serve our customers by designing and building innovative products with integrity. We are ISO-certified and do as much as possible in-house. We have a state-of-the-art machine shop and do all assembly at our facility in Fairfield, New Jersey," Zucaro says. "Our goal is to create standardized products that meet customers' unique needs, which is a strength of AZCO. Our more recent Building Blocks of Automation machines took this to a new level with an update in control technologies."

These converting machines allow customers to select specific modules that mount on a SmartFrame. Customers only need to connect power, Ethernet and air to the modules to begin production. The modules can be freely arranged, and they can be removed or rearranged to adapt to new products, materials or processes.

A recent machine for a large end user included 17 modules: several unwinds for the material, transducers for tension control as roll diameters change, an accumulator to switch from intermittent to continuous motion for feeding material before cutting it, a slitter and traversing knife, as well as a lamination station.

"To provide this much functionality, most companies would have to design a machine from scratch. We simply selected from our standard components and installed them on a SmartFrame," Zucaro explains. "This approach offers tremendous flexibility and cost savings quickly, and our customers have the flexibility to reconfigure the machine or add new functions in the future."

FINDING ENOUGH FLEXIBILITY

The Building Blocks of Automation's inherent flexibility creates technical challenges. The machines require control and networking technologies that can easily plug in and work, according to AZCO Controls Engineer Krunal Padmani. In addition, the AZCO machines need to be able to connect to existing production lines or other equipment, which means communicating with a wide variety of fieldbuses.

The controller, I/Os and other technologies for each module must sit inside a compact enclosure along the SmartFrame. By maintaining a similar controls architecture across 80% of the product line, AZCO can also build stock control panels, which further reduces lead times.

"With the Building Blocks of Automation, we preprogram and preconfigure as many pieces as possible, so we don't have to redesign and retest later," Padmani says. "We want to develop our programs using function blocks and subroutines assigned to different subassemblies, and operators can easily turn them on or off from the HMI."

However, the company's legacy PLC and networking technologies struggled to provide advanced functionality, adequate reliability and hot-connect capabilities to switch out modules. The PLCs created a bottleneck, and, at first, AZCO tried to supplement them with additional controllers and communication technologies. But this meant additional costs for performance that didn't cut it.

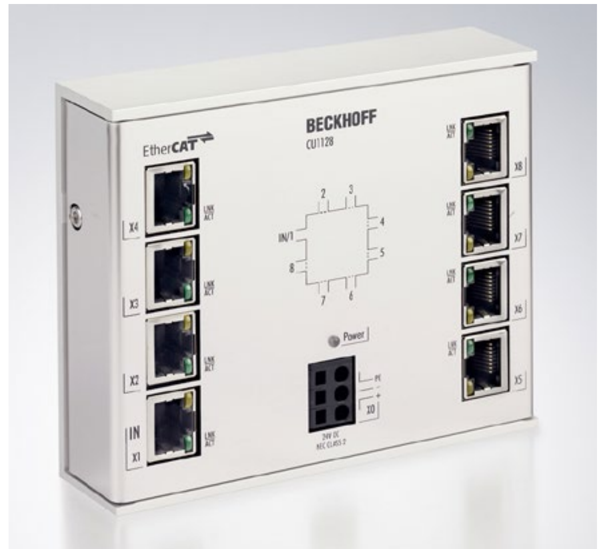
During this time, Zucaro recalled a PC-based controller from Beckhoff Automation, which he had seen when attending Hannover Messe 2018. He was pleased to find a compact industrial controller with an onboard touchscreen that could deliver the needed performance.

"The integrated control philosophy offered a perfect fit for the Building Blocks of Automation with a similarly flexible and modular design," says Tim Beckel, regional sales engineer for Beckhoff. (www.beckhoff.com). "From our early discussion, it was clear that PLC obsolescence was an issue, as well. AZCO was fighting with old versions, and Beckhoff could provide a solution for the present that would scale and provide a clear migration path in the future."

ETHERCAT MAKES MACHINE MODIFICATIONS EASY

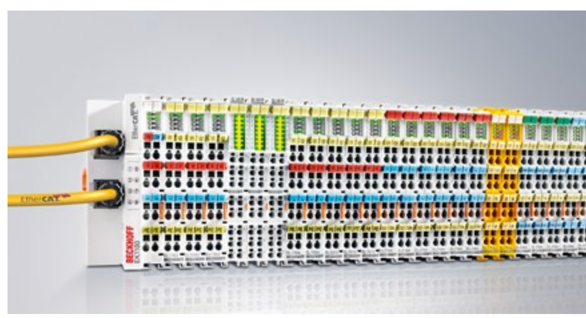
The EtherCAT industrial Ethernet system provided additional networking capabilities with a broad I/O portfolio from Beckhoff. When evaluating EtherCAT, AZCO recognized five distinct advantages over its legacy fieldbus, according to Padmani:

"These included high synchronization, real-time speeds, low latency, system openness for all kinds of devices and free selection of topology. We can use star, tree, ring, line or any combination of topologies without any impact on performance." The Hot Connect feature of EtherCAT also helped to make the Building Blocks of Automation concept work; engineers simply plug in any module to a CU1128 EtherCAT hub via standard RJ45 sockets (Figure 3). Hot Connect also allows the remaining modules to continue working when one piece is removed.



PLUG-IN
Figure 3: The CU1128 EtherCAT hub allows AZCO to leverage the Hot Connect capability of EtherCAT, simply plugging in or unplugging modules as needed. (Source: Beckhoff Automation)

The electrical cabinets feature several Beckhoff I/O solutions, including EL1859 eight-channel digital-input terminals and EL2521 one-channel output terminals. "The output terminal supports pulse-train functionality up to 24 Vdc, which was ideal to operate several third-party dc servo motors," Padmani explains. "These motors have built-in control and encoders, so they only require pulse-train output to the device. With the distributed concept, we can install the EL2521 terminals very close to the servo motors, which eliminates electrical noise that previously affected the system." Along with a new implementation of integrated functional safety via TwinSAFE terminals, AZCO uses the EK1100 EtherCAT bus coupler to connect the I/O segments directly to the machine controller (Figure 4).



CONTROL CONNECTION
Figure 4: The machine is equipped with standard EtherCAT I/O technologies, which connect to the machine controllers via EK1100 EtherCAT bus couplers. (Source: Beckhoff Automation)

CONTROL SOLUTIONS SUPPORT MODULARITY

For module control, AZCO implemented CP6606 "economy" panel PCs. These devices combine a 7-inch touchscreen and an industrial controller with ARM Cortex-A8 processors, a 1 GHz clock speed and 1 GB DDR3 RAM.

"We picked this ultra-compact touchscreen because it offers a PLC and a quality-resolution HMI in a single unit," Padmani explains. "Now we don't have to program PLC and

HMI on two different platforms. It's all in one." Each CP6606 is face-mounted to the top of the 18-by-18-inch electrical cabinets, which supports the distributed, modular concept of the Building Blocks of Automation (Figure 5).

As a universal engineering environment and runtime, TwinCAT 3 automation software allows AZCO to easily reuse code for each new machine, further modularizing the design. The software offers engineers a free selection of IEC 61131-3 programming languages and their object-oriented extensions, computer science languages found in Microsoft Visual Studio, a variety of built-in function blocks and other options in the graphical editor.

"We use the PLC, HMI and motion control functionality in TwinCAT, but we plan to offer customers additional communication options, like OPC UA, MQTT and AMQP, in the future," Padmani says. "This will allow us to send data and perform remote troubleshooting."

ULTIMATE MODULARITY IN CONVERTING MACHINERY

The PC-based control and EtherCAT technologies provided modular control and higher synchronization with dependability for today and expandability for the future. The collaboration between Beckhoff and AZCO has only just begun, according to Beckel: "As customer specifications develop, the flexibility of the Beckhoff system will allow AZCO to expand into areas such as IoT, remote I/O or plug-and-play solutions to add new building blocks."

INTERFACE AND CONTROL
Figure 5: A CP6606 panel PC serves as the HMI and machine controller in each 18-by-18-inch electrical cabinet along the SmartFrame. (Source: AZCO)

In the past, AZCO had to increase panel sizes dramatically when building more complex machines. The compact EtherCAT and control solutions allow them to stock standard control panels for these machines, promoting faster deliveries. After these successes, Padmani looks forward to easy integration of more than 30 communication profiles at end user facilities, such as Profinet, EtherNet/IP and CANopen, using Beckhoff bus couplers. "As we refine our standard, we will reduce assembly and programming time, while boosting system modularity," he adds.

With a new controls approach, AZCO fully realized its modular machine concept. The Building Blocks of Automation machines

When evaluating EtherCAT, AZCO recognized five distinct advantages over its legacy fieldbus.

offer outstanding flexibility for end users, according to Zucaro: “In fact, one customer visited our office for a meeting and noticed the demo machine that we assembled for trade shows.

Using these standard modules on our Smart-Frame, they were able to produce product samples within just two hours, without even planning to make anything before arriving.

With other machine vendors, that would have taken weeks or months of design and testing. We have proven that this concept reduces engineering time, cost and labor, and we are excited for the future.”

Margie McKeon is in marketing at AZCO (www.azcocorp.com). Contact her at mmckeon@azcocorp.com.

Transforming HMI to Meet I/O and Environmental Extremes

Sealevel's extensive embedded computing and I/O line delivers monitoring and control for applications ranging from single inputs to robust I/O expansion. Our experience with serial, digital and embedded products make us the trusted developer and manufacturer for critical communications. Wide-ranging industries, and every major military contractor, recognized Sealevel for our unmatched engineering expertise, world-class manufacturing and customer satisfaction commitment.

HMI for Industrial and Hazardous Locations

Sealevel partners with an industry leader in process heat maintenance to provide an industrial HMI for use in hazardous locations. The system is also required to operate in an environment where temperatures fall to -30°C and heaters are not an available solution. Sealevel engineers, tests and manufactures a COM Express-based HMI to meet the Class I, Division 2 and ATEX requirements and has proudly supported the customer through multiple generations of the design.

RESILIENT & RELIABLE

- 5-Wire Resistive Touchscreen
- NEMA 4/IP64 Front Bezel
- EMC: FCC/ISED Class A, CE
- Class I, Division 2 Groups A, B, C, D, T4
- ATEX/IECEx: 3 G Ex ic ec IIC T4 Gc

SECURE SOFTWARE FOR THE EDGE

- Designed for Windows 10® IoT Embedded
- Hardware Drivers for System I/O

INTENSE I/O & FUTURE PROOF DESIGN

- COM Express Design
- Intel Atom® Processor
- Ethernet, Serial, USB and Digital

System Design & Requirements

Sealevel's team begins by determining the specific I/O expansion, processing, and environmental system requirements as well as any environmental considerations.

Electrical, Mechanical & Test

Sealevel's team of electrical, mechanical, software and test engineers guide every computing product - standard and custom - through the design and manufacturing process.

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Sealevel uses a "design for certification" approach to manage the product development cycle to meet military and commercial certifications.

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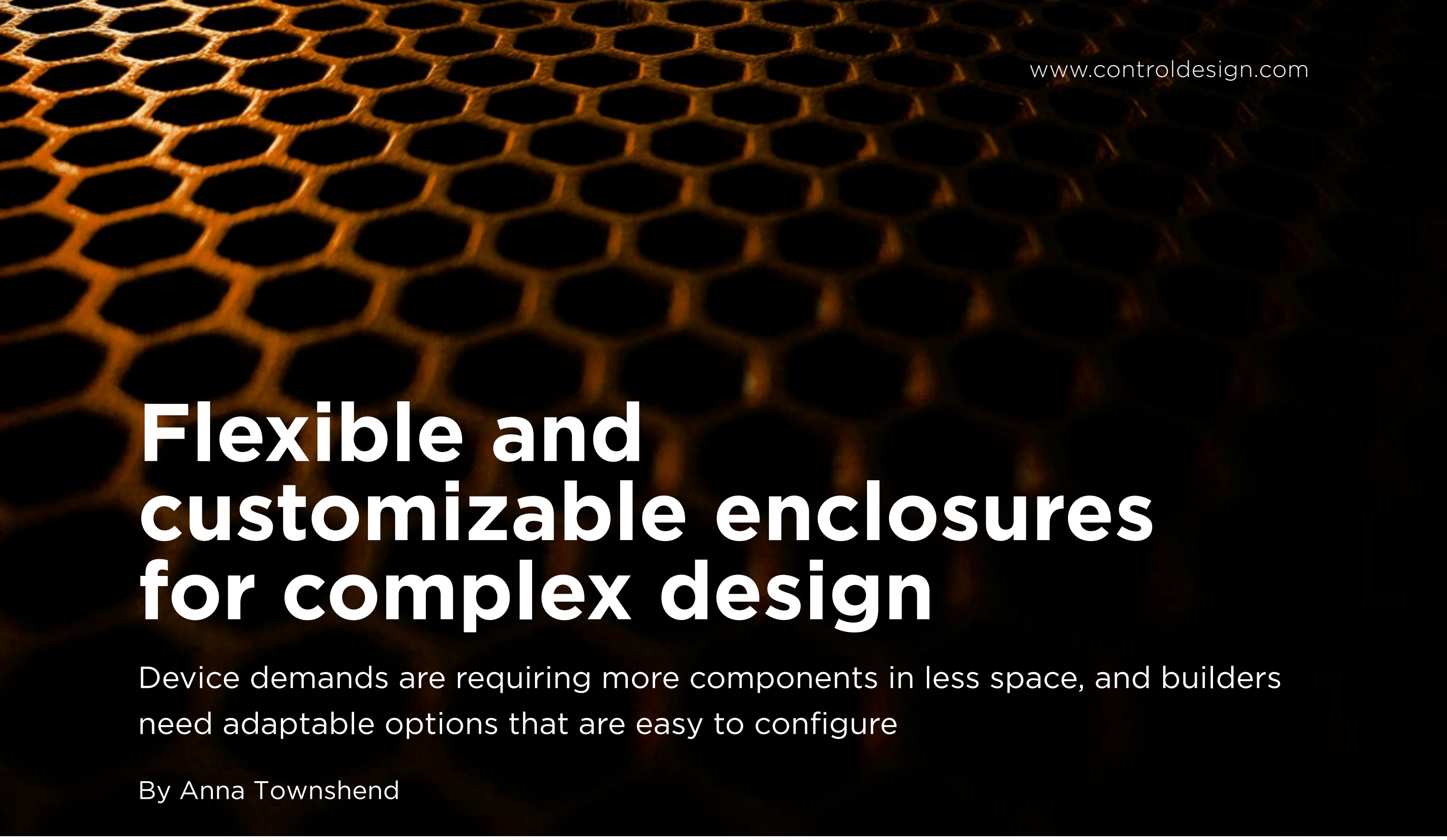


Flexible and customizable enclosures for complex design

Device demands are requiring more components in less space, and builders need adaptable options that are easy to configure

By Anna Townshend

Machine builders are expecting more out of standard enclosures for industrial automation. This is driven by trends in increased networking and cloud communication and the need for this advanced technology to perform in challenging environments. Two manufacturers, Phoenix Contact (www.phoenixcontact.com) and nVent Schroff (schroff.nvent.com/en-us) provide some flexible enclosure options that cater to the current demands of device connectivity and their complicated designs.

SEAMLESS INTEGRATION

Most new machine builds are incorporating IIoT gateway devices that communicate with a variety of existing networks, transmitting vital plant information to the cloud. More plants are also requiring asset monitoring, and, where remote monitoring capability was once the exception, it is now the norm, says Joel Boone, product marketing manager, device connector solutions, Phoenix Contact. Increased functionality has led to more choices and the need for more connection flexibility.

Phoenix Contact has been producing electronic device cases for about 30 years. While its specialty has always been field-wireable connectors, the company also saw a need to accommodate the growing variety of connections needed in complex gateway devices. It created the Industrial Case System (ICS), which can seamlessly integrate a variety of connectivity options.

"As we get into edge computing, and, instead of having all processing power being done in one central location, needing to push computing power to the edge of networks, it's really important for devices to be able to communicate with a wide variety of I/O and other devices," Boone says.

Phoenix Contact has always worked with different types of connectors—RJ45s, D-Subs, USBs—by milling whatever necessary holes into its enclosures to accommodate those connections. "That's just not the cleanest solution for an OEM," Boone says. The ICS allows for all those different types of connections in the enclosure without costly, secondary modifications, Boone says.

"Machine builders that have been focused on traditional methods of developing an entire system and maybe not looking at cloud computing, that's kind of not an option moving forward," Boone says. "End users want to be able to monitor what's going on with their machines to make real-time decisions to better production, to produce the most amount of yield coming off of those machines."

Asset monitoring and remote capability will only get more complex, Boone says, and the hardware needs to be similarly complicated, yet adaptable. "Having hardware that matches that complexity is critical to being successful in the market," he says.

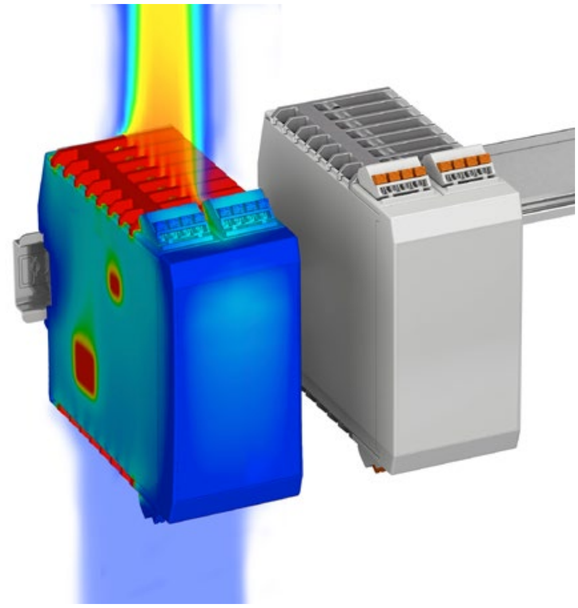
To accommodate a variety of complex connections without off-the-shelf modifications, the assembly is very simple and straightforward. "It all snaps and slides together very cleanly," Boone says. "The connections are supported with the appropriate openings in user-selected panels that affix to a PCB and then slide into the enclosure."

The ICS can be modified to match a customer's brand or aesthetic, and, while its flexibility makes the product customizable for many clients, its ability to be scalable highlights the range of its quick adaptation. "It's meant to be scaled for someone using 10 or someone using 10,000," Boone says. "You get a lot of options with it that are easy to configure."

All this variety and functionality presents some safety issues. With wireless gateway devices, the system must prevent hacking, and cybersecurity concerns are only growing as systems become more complex. "You've got to make sure products are safe," Boone says.

"With all that functionality in one module and one complex set of electronics, you might use system or module electronics or you might build in dedicated functionality that you just tap into for a completed module, so all of that leads to a lot of computing power in a small space. When you have that, you have heat," Boone says. Electronics also continue to trend smaller and smaller, requiring more heat-dissipation options (Figure 1). "The enclosure that you choose always has to be able to dissipate some heat," Boone says. "But, if it's not sufficient in the operating conditions in the end environment, you have to find other ways to get heat out."

In addition to traditional venting options, the ICS can incorporate heat sinks that easily slide into the same areas on the enclosures, where users also integrate connection technology. "It's a really clever design that allows a customer to easily use some of the more complex and hot running microelectronics," Boone says. "They can be easily incorporated into the system."



SMALL HEAT
Figure 1: Electronics continue to trend smaller and smaller, requiring more heat-dissipation options.

All the components and all the computing power that can be incorporated into the ICS can make for complex designs, so the system also includes an online configurator tool to help with the complicated design process. Boone says he also uses the system on a daily basis with potential customers to look at the capabilities of different systems. "It steps you through, based on the sizing that would make sense for an application," Boone says.

It's a graphical drag-and-drop tool that allows users to place components on the digital housing as they want them in the actual enclosure. Once a user has created a full housing, the system provides a full bill of materials and a downloadable CAD file that includes the printed circuit board (PCB) completely configured, based on component selections and layout. It also includes a link, so users can go back and make changes later.

For those concerned about hot spots, the online configurator tool can run a thermal simulation on up to three hotspots. The system can perform an analysis to determine if the layout will cause heat issues or if further heat dissipation is needed.

LEVELS OF PROTECTION

The Varistar configurable 19-inch equipment rack platform from nVent Schroff also offers users an online design tool to configure layouts without engineering or software skills. "The user can design a rack that is configured from a catalog of standard components," says Robert Zeuge, product marketing manager, nVent Schroff. The design tool is Web-based and accessed via the nVent Schroff website, and users receive a bill of materials, a CAD model of the assembly and the needed item numbers.

"The platform is able to be configured for the needs of many different industries and applications," Zeuge says. Examples of industrial applications for this product include laboratory equipment, industrial test equipment, industrial process control equipment, telecommunications and data-communications equipment, and railway control equipment. Many of those applications operate in rugged and rough environments, requiring protection from many elements. The rack is made of a welded steel frame with steel sides, covers and doors (Figure 2). "There are options for perforations, glass doors and gaskets to seal the enclosure from the outside environment," Zeuge says. "Other options include a suite of cooling products to manage the heat load."

The enclosure has a high ingress protection, rated on the IP scale (the first letter rates protection against physical objects in the air such as dust, and the second digit represents protection against water or moisture). The standard rack platform is IP20, and the gasketed rack is IP55.

"The gasket that provides the shielding also provides IP55 protection. This feature isolates the equipment inside the rack from outside electromagnetic fields and similarly prevents electromagnetic fields from the equipment inside the rack from interfering with the process and equipment outside the rack," Zeuge says. This is beneficial, he says, if the equipment or process is sensitive to electromagnetic interference, such as sensitive measurement equipment or a process that uses magnetism or creates magnetic fields.

RACK PLATFORM
Figure 2: The rack is made of a welded steel frame with steel sides, covers and doors.

The system can perform an analysis to determine if the layout will cause heat issues or if further heat dissipation is needed.

The Varistar enclosure provides advanced cooling solutions to dissipate unwanted heat. Fans, blowers and air movers cool the equipment inside the rack. “Slightly more advanced would be filtered air movement to cool the equipment, while also maintaining ingress protection against the outside environment,” Zeuge says. The most advanced cooling solutions include air to water heat exchangers to provide up to 40 kW of cooling power to the rack. “The specific aspects of the thermal solution will depend on whether the heat source is the equipment operating, or the outside environment, or both,” Zeuge says.

Along fault lines, upgrades to the enclosure can provide shock and vibration protection for earthquake resistance to NEBS zone 4 and shock resistance in military environments to MIL-STD 901-E.