controldesign.com

control design

HMI, Industrial PCs and Enclosures

PART 2

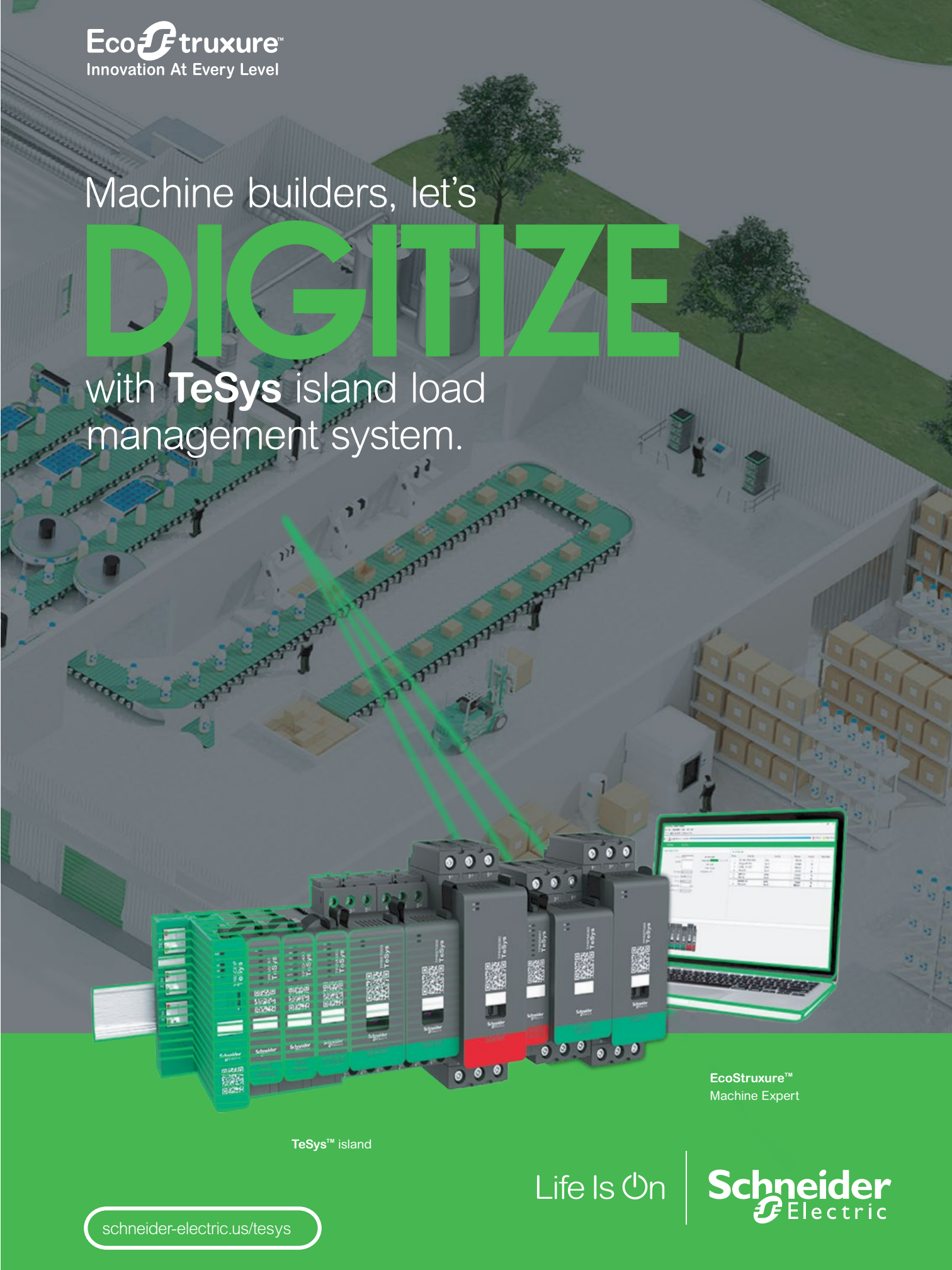
PutmanMedia®

TABLE OF CONTENTS

AD INDEX

EcoStruxure™
Innovation At Every Level

Machine builders, let's DIGITIZE with **TeSys** island load management system.



EcoStruxure™
Machine Expert

TeSys™ island

Life Is On | Schneider Electric

schneider-electric.us/tesys

The next level of operator interface

By Rick Rice

It's 1979. Your machine has suddenly stopped. You walk up to it with a million questions, but the most important one is: "What is wrong?"

Maybe you are lucky, and someone heard a clunk. Perhaps there is physical evidence; one of the widgets is jammed in a clamp station. You might even be fortunate enough to have a machine that has status lights that tell you when there is a motor overload or one of those high-tech machines where the designer has a graphic representation of the machine on a big board with little lights at key locations around the picture to show you where to look for the source of the trouble.

Or imagine that you have none of those features available, and you are faced with a machine that stopped running and no idea where to start looking for problems.

Many might be surprised to learn that, here in 2019, there are still machines and processes out there that still don't have a human-machine interface to aide with the operation. Many vintage machines are still around because they were built to last. In the absence of a means to graphically display the operating conditions of the machine, the owners of these workhorses would resort to hiring and training people with advanced skill sets to compensate for the lack of a window into the function of the machine. The investment in human resources was key to the success of a company.

As machines and processes became more sophisticated, a means to provide better information for the operator or technician became a very important addition to the design of a control system. Cathode Ray Tubes (CRT) had been around for years but the use of the technology didn't reach the mainstream of control systems until the late 80's when several manufacturers brought out devices that combined the display capabilities of a CRT with the input capabilities of a membrane keypad. These early HMI (human-machine interface) or OI (operator interface) used the CRT to display the status of bits and integers in a PLC and the membrane keypad provided a means by which to provide input to the PLC as well as a means to navigate to different screens that were displayed on the CRT.

Much has changed over the ensuing 30 years. The advent of the touch screen eliminated the need for the membrane keypad. CRT's have given way to LCD (liquid crystal display), plasma (small cells containing plasma that are then excited by electrical fields), then LED (light emitting diode) arrays and, most recently OLED (organic light emitting diode) technology. It is the progression of the display technology that has had the largest impact on the use of an operator interface in a control system. Screen resolutions are greatly improved as is the viewing angle and the screen contrast. These improvements have prompted a change in the type of information that is exchanged between the PLC and the operator.

Early HMI's were really nothing more than a mimic board in an electronic format. Pushbuttons and selector switches, status indicators, numerical display and inputs were common elements of these early devices. As the graphic ability of the technology improved, the ability to display elements that looked more like the physical devices greatly enhanced the appearance of the HMI. The representation of objects on an HMI was originally limited to the use of a combination of squares (rectangles), ellipses (circles), creatively placed such that some of the constructs of the object could be hidden by placing objects on top of objects. Later versions could accept imported graphics from programs like Paint and, if properly formatted, these devices could be made to have dynamic properties that allowed for the image (or a portion of it) to change colors to represent the status of the actual devices. An example of this would be an image of a vessel that shows the level of the contents of that vessel.

One of the key features of those early HMI's was the realization that a savings on wiring could be realized by using the HMI instead of physical buttons on an operator

panel. This added the ability to not only control the process via the HMI but the HMI could be used to enable/disable functions at a level not reasonably possible with a panel of physical buttons and selector switches. The downside of doing this in a control system is the risk that your system being inoperable if the HMI fails.

Fast forward 30 years to 2019 and we see a significantly different human-machine interface. Screen resolutions in the area of 1280x1024 pixels bring crisp graphics and fast connections to the PLC result in animations of functions that are practically seamless. Package sizes are dramatically smaller, resulting in the ability to put a significantly larger screen in the same cutout as a much smaller version. The bezel on an operator screen used to be as much a 2" outside the size of the screen, mostly in order to support the weight of the screen itself.

Another major advance has been in the area of communications. Early operator interfaces were limited to RS-232 protocol communications with speeds as low as 300 baud (bits per second). Todays' HMI communicate at speeds of 100 million bits per second or greater. Faster speeds means far better responses to the pressing of a button on the screen and the PLC receiving the input from the screen.

Two recent additions to the tool set of an HMI is the ability to run Active-X and PDF content from the user application. The former means that other applications can called from within the operator interface application. The latter has opened up the possibility of including hardware and software manuals on the operator interface and custom documents relative to the machine or process being controlled. The advantage here is that the operator or technician doesn't need to retrieve the manual from an electrical enclosure or maintenance shop library. They can access the manual right on the operator interface itself. This significantly decreases the time needed to access appropriate information in the path to restoring a machine to operation.

Technology is only one of the advances in the human-machine interface. One trend that has, happily, gained traction is the unification of the PLC and HMI programming environment. Most major hardware suppliers have long had the ability to import the tag database from the PLC into the HMI software development application but it formerly involved an intentional action to export the database from the PLC for use in the HMI or an action to point the HMI application at the PLC application in order to upload the tags into the HMI application. The focus on fully integrating the PLC and HMI development applications into a "suite" has resulted in a practically seamless unification of the two

applications during development. In this type of cooperation between applications, a tag can now be created in the PLC database from within the HMI development software. Another new feature allows a tag to be identified as an alarm tag in the PLC and it is automatically included in the alarm list on the HMI.

Two other features of new HMI's are high-speed tags and add-on graphics. High speed tags are assigned in the same manner as other HMI tags but are designated as high-speed tags. Think of this in the same was as an immediate input or output in the PLC. Buttons, so defined, are deterministic and auto-diagnosing, allowing for an HMI button to be used for jog functions that would normally involve lag that might make them less than desirable for that purpose. Custom, re-usable add-on graphics are a new feature that has great advantages for development of operator interface applications. The developer can create custom graphic elements and then save them in a library for future use. This pre-built content can significantly reduce the time required to develop a new application.

The next two features are definitely the children of smart phone age. Newer HMI's have built in VNC servers that allow access to the operator station via network with a smart phone or tablet. This tool is a boon to operator and maintenance mechanic alike as a smart phone can be used as a remote control device as one walks around the machine or process. In a further nod to the smart phone, some human-machine interface units now have a navigation button, similar to the "home" button on a smart phone or tablet. Pressing this button brings up a navigation bar on the HMI that can be customized to suit the application. The great advantage of this feature is more of the normal operator screen is available for content with the navigation button used to pop up a graphic with the customized navigation bar.

While today's human-machine interface seems to be nothing like the HMI of yesterday, there are still some things to keep in mind when using this technology. The HMI is a tool, both for the user and the programmer. A tool is only useful if people are going to use it. Aside from the obvious control elements, a good HMI application also serves duty as the primary window into the inner workings of the machine or process. Build on the development of applications and employ continuous improvement on your design. Once the controls are in place, add troubleshooting by including a graphical display of the input and output modules of the PLC. Add screens to display the status and command structures of your VFD and servos. Think about adding popup help to your machine status page. Compare it to how easy it is to use your office copier now

that a step by step prompt with pictures follows you through clearing a paper jam.

Finally, if your process or machine doesn't require many changes once set up, consider keeping the main controls as physical buttons to allow for operation in the event of an HMI failure. The same goes for a machine where starts and stops are common. No sense wearing out the touch screen with constant use of the same spot on the screen.

The operator interface of today isn't just a replacement for an operators console any more. Value-added features are coming out with each new product release and it is very important to stay up on the vendor literature as many features make the design process quicker and the result is an elaborate application that enhances the user experience.

Simplify hazardous-area HMI design

Engineering types may enjoy acquiring and studying all the standards needed to deploy an HMI in a hazardous area, but sometimes it's better to let others do the footwork

By Dave Perkon, technical editor

Fire and explosions are major concerns in industrial plants where flammable gases, liquids, vapors or combustible fibers or dust are present normally or under abnormal conditions. Field devices such as illumination, sensors, solenoids and actuators used in these locations must be properly rated and labeled.

This, of course, includes the human-machine interface (HMI), which often needs to be located where the action is in these hazardous environments. You can design your own system to meet the requirements, but off-the-shelf options for hazardous-area HMIs should be considered, as there are many requirements to follow to ensure operator safety.

Whether the area is a hazardous location defined via North America's class/division codes or international Atmosphere Explosible (ATEX, European Directive 2014/34/EC) or similar codes, most hazardous-area electrical device installation instructions clearly point out that planning installation, commissioning, operation and maintenance is the end user's responsibility.

The suppliers of this hazardous-area-rated equipment make it clear that the installation and commissioning of the devices require qualified, trained personnel. If the HMI, for example, is not used for its intended purpose, protection of the user is not guaranteed.

Starting with the area classification provided by the location owner, do you really want to assemble all the components needed to operate an HMI in the hazardous area, or should you buy something off the shelf? Well, the details in National Fire Protection Association (NFPA) 70, National Electric Code (NEC) articles 500 to 506, are many, so read carefully.

An HMI on a machine or process in a hazardous area consists of much more than just a graphic display. The display needs to be mounted in an enclosure, and usually more than just a basic enclosure is required, especially in Class I, Div. 1 areas. HMIs mounted in NEMA 4X stainless-steel enclosures behind Plexiglass is the norm. Purging—the right type of purging—of the enclosure is also required.

There are many other things to consider if designing your own hazardous-area HMI. It may be behind Plexiglass, so consider the viewing angle and touchscreen access. Not only may the graphic display be difficult to see, the touchscreen may also not be accessible in Div. 1 areas.

There will be considerations for the peripherals—for example, the keyboard and mouse must also be suitable for use in the location. Even if the device is protected by an intrinsically safe barrier, the keyboard or mouse itself must be labeled for use in the location with the cables carefully isolated from all non-intrinsically safe circuits in the enclosure.

And even the type of HMI/display inside the purged enclosure is important. For example, use of a flat-panel display may be required to minimize power consumption and the related heat generation, which could cause an explosion depending on the group rating, or type of flammable gas, for example, in the area.

Ensuring a safe and proper design in a hazardous location is a big task that many industrial suppliers have recognized, so there are a variety of graphic and text terminals on the market to provide machine and process monitoring and control in hazardous areas.

To keep the cost down, these product offerings are often intrinsically safe devices. As with any electrical device in a hazardous area, approval for use in that area, such as Class I, Div. 1, or ATEX zones 1 and 2, must be clearly indicated.

Manufacturers provide very detailed and complete information related to certification of compliance of electrical devices for use in hazardous locations. With the hazardous-location classification in hand, check the HMI specifications very carefully while shopping around.

When searching for a keyboard or mouse

An HMI on a machine or process in a hazardous area consists of much more than just a graphic display.

to connect to the HMI or graphic terminal, be sure to search carefully through the documentation and certificate of compliance. While the keyboard may be able to operate in a Class I environment, with flammable vapors and liquids present, it cannot do it all the time, such as in a Div. 1 area. And many hazardous-area devices may be certified for Class 1 areas but cannot be operated in a Class II area where explosive powders are present.

There are many differences in the national and international specifications, as well. In NEC, Article 505, it's noted that division-classified products may be installed in zone-classified locations, but the opposite is not true. The zone classification utilizes protection methods not available in the class/division scheme. Look at the labels.

A variety of protocols are used to connect the HMI in the hazardous area to the PLC or PC-based control systems, which are often located in safe areas. Industrial Ethernet protocols such as EtherNet/IP, Profinet and many others are available. Consider these protocols to minimize connections. Also, consider the use of a keyboard, video and mouse (KVM) extender unit to connect to a remote monitor, keyboard and mouse in the hazardous area.

Visualize organization from chaos

HMI design should account for the information that is required to be seen by an operator

By Jeremy Pollard, CET

I remember my first HMI project. It was back in the late 1970s, and it was a project for a steel plant that was retrofitting a blast furnace. I was working for Allen-Bradley at the time, and in fact my customer used the project for a marketing brochure, including me in the picture.

I was going to be famous. Well, maybe not, but it was a very cool project. “What was the platform?” you may ask.

An operator panel that was more than 6 feet wide had lamacoid cutouts mimicking the operation. It was in fact called a mimic panel. There was a PLC behind all the lights and sirens, along with a CRT to display a portion of the PLC program from the dedicated programming terminal – remember the 1770-T3?

The intent of the panel was to show the complete operation in one place. There were panel meters for analog display of pressure, temperature and flow. Small DC pilot lights were used for digital data.

It was a very compact and functional display. It worked.

Today however it would have taken probably at least four screens to display the information on an HMI. All of the information could not be displayed on one screen, but good HMI design should account for the information that is required to be seen by an operator.

I am currently involved in a PLC conversion project, which includes an HMI upgrade. HMI application software development is an expense. Time is money, so let's not spend too much time on the HMI development.

Quoting an HMI project is no easy task. The mimic panel was easy. The customer gave us a drawing of how they wanted it to look. Which customers these days go through and generate screen designs for their HMI projects?

The current HMI screens for my conversion project are only six years old, but you would think that it was developed 30 years ago. The design is really bad, and the data flow is worse than that. There are page after page of data points that seem unrelated, although there is a main menu where you can select a destination screen.

However, to get to another screen you have to go through the menu again.

So, there really isn't any overview of the operation, making the understanding of the process a chore.

So, my challenge is to convert what is there from something that is an organizational mess to organized screen and data flow. Piece of cake, yes?

Well, as with most HMIs, there is only once screen. With limited real estate, HMI design is and has to be very different from SCADA design. I have seen a SCADA system with a massive 42-inch screen that was broken into four screen areas, as well as systems that have multiple monitors that allow for a design and presentation that aids the operators by creating a mimic panel type displays.

HMI isn't so lucky. And now you know why larger-screen HMIs are more expensive. The larger real estate is worth money.

So much happens behind the visuals. You can't possibly put everything on the main screen to represent the operation of most processes.

Another gotcha with HMIs typically is that sometimes there are no operators that look at the screen on a constant basis. They only go to the HMI when something needs to be changed or there is an event that requires their attention.

Very rarely do operators watch an HMI screen when the process is running. It is a window into the world when the process stops running or if it stops running well.

HMI design is and has to be very different from SCADA design.

My conversion project will not have a local operator.

Does that change the design criteria? Sort of.

When something happens, the information needs to be presented in a format that can be readily understood, and normally it comes down to alarming.

I have developed HMI systems in the past that bring up certain screens based on the alarm that happens, so the information that operators need is presented to them when they have the need to view the results of a process move.

But it all took time, effort and pride to create an effective HMI system for the client. HMI systems require your complete attention from a design, as well as an implementation point of view. You don't have screen real estate to create an overview that includes everything. Alarming becomes so important, which reflects on the PLC code driving the HMI data.

Screen navigation is as important as content. It's easy to display some numbers, but doing it with organization isn't as easy. The mimic panel had it all on a 6-foot screen.

Doing it in 10 inches is a challenge. Take the time.