Don’t forget the drawings!

A good set can help save time and money in an automation project

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AUTOMATION PROJECTS are multifaceted. They include perhaps mechanical equipment, PLC’s, human/machine interfaces, and a long list of other physical items. But don’t forget the drawings. Drawings hold a unique place in the project. They are both the plan and the record. They are both the guide and the source.

And ultimately, a really good set of drawings can save you time and money—and generate profit. No matter how small or large your project, you’re going to have drawings. And this is definitely a case where the more you put in, the more you get back in return.

Currently in the U.S., electrical drawing basics can be referenced in NFPA79. This specification covers control panels and controls design. Electrical symbols for controls contacts and practices are defined here. Key elements of a drawing package may include a number of items.

Machine/process layout

This layout shows the location of your devices. These devices can be identified with a unique device number or, in many cases, a device number that is related to the PLC I/O. The control panel location, any conduit, or raceway wiring may also be indicated on this drawing as it relates to the system assembly of the machine. Some manufacturers also include cable and conduit breakdown schedules showing for each the number of conductors and their wire numbers.

Device labels can be chosen with a universal type of prefix indication according to the type of device, such as *PE* for photoeye or *PX* for prox switch. With the increased attention to safety concerns in the U.S., new machine manufacturers are adding specific safety device location and information on the device layout pages of their drawings. This may include safety entry and exit points, pullcords, or other safety devices. Lockout-tagout locations should also be identified.

Control panel layout

A control panel layout serves a number of purposes. During the manufacturing process, it’s the guide to the panel builder and indicates how the control panels are to be assembled. Therefore, a detailed layout showing the location of each device will reduce panel shop time. After the panels are built, these layout drawings become the startup technician’s assistant in locating devices during system commissioning.

Really, in the opinion of many people, the most important function of these layout drawings is to provide service personnel with device locations later in the machine’s lifespan when it needs service. Many designers are now including wire numbers and device numbers on these layout drawings in addition to the device name or description.

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Power distribution pages

Most systems have three-phase power devices of some sort. These may be motors, drives, brakes, magnets, clutches, or a variety of other items. All of these devices require 480 volt power. The 480 volt distribution pages can be a key to understanding the machine or process. If they are laid out in a structured manner, identifying the devices with detailed names that describe the function, and proceed in the manner of operation for the equipment, then they can truly lead the programmers or service technicians through their process of understanding.

While drawing specifications define the basics for the 480 volt power distribution design, additional information added to the drawing pages can also be a timesaver later on. This additional information might include wire gauge size and colors.

This helps the panel builder to be certain of the correct wire sizing when building. Notes on the location of devices, or perhaps a legend indicating device location for multiple machine centers of control, could also be included. This is significantly helpful, especially if there are distributed control or power panels.

If power connections enter and exit through connectors or terminals, it will be helpful for the field installation technicians for these devices—their location and pin numbers—to be identified on the drawings.

Control voltage distribution

Over the past twenty years or so, the use of 24 volts d-c has surpassed 120 volts a-c as the control circuit voltage of choice. The exception to this would be where large valves, brakes, motor starters, or other devices that require higher current or inrush are used.

Since this is the case, the control voltage distribution usually encompasses two sets of drawings. First would be the 120-volt distribution used for the higher-current devices as well as the devices necessary for the generation of 24 volts d-c (power supplies). The second set of design pages would encompass the 24 volt d-c control circuit.

As with the 480-volt pages, basic design of these circuits is covered by design specifications. However, some changes in drawing habits have evolved in recent years. These include indication of color-coding for all wires. Showing this coding on each individual page relating to specific sets of wires is a change in practice where the previous method was to define a color-coding standard to be shown on the front of the drawing packet.

PLC control I/O

The bulk of a drawing packet in current machine design is taken up with programmable logic controller or

other controller types of I/O. These pages show integration of the field or control panel components or sensors into the control system.

The most significant part of these pages is also the most time-consuming. It requires the most effort—to get as much information related to an I/O point as possible onto the drawings. Rather than labeling an input as *PX001,* including the device description of "Cylinder Home" pays tremendous returns later in saved labor. Depending on the size of the system, there can be one or two of these pages or a hundred.

Network page

This page has come into being and evolved significantly over the last ten years, but now it can be of the utmost importance in the entire drawing packet.

The ultimate goal of the network page is to define the communication of devices within the system. By this we mean the PLC, HMI, or other intelligent processor-based devices and how they send information to each other.

Many systems today now have multiple types of networks within one system, including Ethernet, proprietary networks, serial, or others. The network page provides a communication overview for service technicians and engineers that allows for an understanding of data flow between the intelligent system devices.

If I/O is being used in an HMI via an Ethernet network to the PLC, the visual representation of this network connection will give a clue to the technicians not only of its existence, but how it is communicating. The most important thing on the network page to be communicated other than the type or types of network is the network configuration information.

For example, if an Ethernet network is being used between the HMI and the PLC, defining the IP address and mask information on the drawing can save a tremendous amount of time in later stages. Proprietary networks can be equally difficult. Showing communication baud rate provides information that may not be able to be reverse-engineered without returning to the machine manufacturer.

Terminal strip pages

Many service shops and small controls builders skip this section of the drawing set because the generation of a terminal strip list can be tedious and time-consuming. Unfortunately, the work eventually gets done anyway, whether it is the panel builder who has to figure it out while it's being assembled, the programmer who has to figure it out in the field to provide to the electrician, or the electrician who figures out the terminals necessary. This truly is one of those items that you have to do eventually but is probably easier to do up front.

Bill of Materials

Most drawing packages have traditionally included the controls bill of materials. However, with the advent of PC-based databases, many controls manufacturers have shifted to a spreadsheet-type of bill of materials. With the current status of CAD packages, these spreadsheets can often be imported into a drawing. Important in the computer software is the ability to modify or complete the bill of materials with the least amount of effort.

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Revisions

All electrical design packages have "stages of life." The first is the concept design. This is where the system criteria is put into circuit format on paper. Usually this is followed by some design review process. The second stage is the approval or construction stage. Many manufacturers require that from this stage on the drawings become "fixed" until the project is completed and the next stage of the drawing process begins.

Upon completion of commissioning of the machine or process project, electrical drawings are revised and issued on a permanent basis. This drawing revision should reflect the information recorded during the start-up and reflect changes or additional information from the commissioning process.

Once the modifications to the drawings are completed, this set of drawings becomes the future source of information for all maintenance personnel.

Computer-aided design

Certainly, most businesses have reached the stage where drawings are done in a computerized format. This requires some CAD package. There are many CAD packages available. Most of the software characteristics and computer skills required are similar. They vary in price, acceptance, and capabilities.

Many large end users such as automotives may require the use of a particular CAD package. However, shops in different areas can usually decide to use whatever package is most cost-effective.

Whatever the choice, the basic requirement for those generating the drawings is the development of a set of libraries for symbols and devices. These would include a library of electrical circuit symbols and perhaps a library of scaled electrical device layouts.

Many component manufacturers now provide some CAD libraries and at the very least, dimensioned CAD drawings on their Web sites for this specific purpose. Electrical symbol libraries can be purchased from various resources on the Internet or from the CAD manufacturers themselves.

There are also software packages available that can assist the designer in the system design. These packages may operate as complete and stand-alone on the PC or may be an add-on to a particular brand of CAD software. They assist the designer in the design process by providing automatic wire numbering, panel layout, assistance with PLC modules, I/O numbering, load calculations, and other helpful items. The packages can be tremendous timesavers but may also require more specific libraries of manufacturer's components.

There are many other types of drawing pages that can be included in a system design. These would vary from each machine or process depending on the application but might include connector pinout drawings, plant floor layouts, nameplate manufacturing information, or single-line reference definitions.

Whatever your level of involvement in controls systems, generation and maintenance of drawings is one of your most important ongoing tasks. Thorough and organized drawing sets ensure that projects and maintenance go more smoothly.

With just a little patience, the benefits are many. ■