HUMAN MACHINE INTERFACE
USING TIA-PORTAL SOFTWARE

Introduction
Communications between processor and HMI (human machine interface) is an important subject as well as constructing an operator interface. The chapter includes procedures for attaching computers as HMI devices to the CompactLogix processor from A-B and the Siemens 1200 processor. Graphic control packages used are A-B’s RSView ME and Siemens’ WinCC. Other packages exist and were not excluded based on their capabilities. The ones used are among the more common and popular ones used today.
The following HMI panels communicating to PLC processors will be discussed in this chapter followed by a lab that can show advantages and disadvantages of each.
Compact Logix WinCC Siemens 1200 RSView ME
In each case, the emphasis is on getting a simple application operational and then expanding from that, remembering the analogy of the kite flying with a simple string over Niagara River. Later, the more difficult applications are discussed but only after a single button is programmed from the HMI and communicates successfully to the PLC.

Historical Panel Design
The design of an operator panel requires much coordination with the programming of the PLC and the design of the machine being controlled. Before the computer-designed systems, there were individual component systems that were hard-wired to the control devices inside the panel.

A Simple Control Panel with Push Buttons and Switches with Indicator Lights.
A look back at how HMI Graphics have evolved. First from the 80’s:
Is the pump in alarm or stopped?
Are the valves in alarm or closed?
High Contrast

These three areas are a big cause for eye fatigue.

In the 90’s, the following characteristics were thought to be important:
Is this a good graphic?
What is the reactor temperature?
What Percentage of the screen is presenting useful data?
The pretty 3D objects and Gradient fill are superfluous
The flame attracts your attention
The moving truck attracts your attention
Overuse of color – causes confusion.

Objects that have high contrast, warm colors or movement draw attention to themselves, causing distraction and fatigue, possibly causing the operator to miss important data. Warm colors include red, orange and yellows and, especially when flashing, draw attention. Also, complex graphics and 3-D models draw attention to themselves and are to be avoided.

The Use of Trending
Using trend displays helps provide Level 3 SA projection of future status. By extrapolating, the operator can then see where the process is heading. The operator can then be proactive and recognize impending problems, rather than being reactive and responding to alarms and problems after the fact. Use trending with thought. For instance, a trend display with eight variables is confusing and takes a long time to analyze. We can see the value and its past trends. We can make predictions of what the value is about to do based on its historical behavior.

BUT
What should the value be? What is the normal good operating high and low limits?
We can see the value and its past trends. We can see what the value should be.
We can see what the normal operational high and low limits are.

Using Color Effectively
Seven to 10% of males are Red-Green color blind. Also, avoid using color alone to express information. Only attract attention to an area of the display if there is an Abnormal Situation. **Introduction and Overview of High Performance HMI**

The process control and automation industry has spent billions on improving process safety via complex, instrumented systems. Yet, we continue to frequently see industrial incidents, accidents, and fatalities in the news. The causes are generally not the failure of such automated systems but are instead the result of a wide variety of human errors. We firmly believe that addressing the causes of human error and the improvement of *Operator Effectiveness* is of the highest importance. The proper use of such technologies as High Performance HMI (HPHMI) and Alarm Management can actually save lives and prevent injuries. Detailed information on these should not be withheld, and that is why we offer this and other white papers freely. They can also significantly lessen process upsets, improve process efficiency, and increase productivity.

The human-machine interface (HMI) is the collection of screens, graphic displays, and other technologies used by the operator to monitor and interact with the control system (typically DCS or SCADA). Several major accidents, such as the Texas City refinery explosion in 2005, have cited poor HMIs as a significant contributing factor. The design of the HMI plays a critical role in determining the operator’s ability to effectively manage the operation, particularly in quickly detecting and resolving an abnormal situation, which is the most important task of an operator. A poor HMI can actively interfere with this ability.

For several reasons, the current designs and capabilities of most HMIs are far from optimal for running the kinds of complex operations we have in industry. Most HMIs consist simply of schematic or P&ID style graphics covered in numbers. Such displays provide the operator large amounts of raw data but almost no real information. They are difficult to interpret and provide inadequate situation awareness to the operator.

Since we published *The High Performance HMI Handbook* in 2008, improving HMI has become one of the hottest topics in the automation industry. In that book, we explained exactly why most current HMI practices were poor, and we put forth the proper principles and details for making graphics significantly better. Many companies have adopted those principles and have completed migrations to improved graphics. Many more have such efforts currently underway.

This two-part paper provides a history, justification, and detailed plan of action for the improvement of a process control HMI. Here is an overview of the contents.

**Part 1**
Examples: We provide typical examples of common but poor HMIIs, along with highly detailed depictions of improved methods that provide for much better operator situation awareness and control.

Principles: We cover the most important aspect of HPHMI, the display of information to the operator rather than raw data. Many other necessary graphic principles including the correct way to use color are provided. Depictions of detailed graphic elements are included.

Hierarchy: HPHMI graphic designs must reflect a proper hierarchy – the exposure of additional detail as needed. We include examples of graphics that illustrate this hierarchy, along with the work processes used to design such graphics. Ch 15 Human Machine Interface 11

If your facility utilizes a process control system with a computer-based HMI, you will find this information useful. This white paper augments the detailed content in The High Performance

“TIA Portal Integrates Engineering Tools

Siemens AG, one of the world’s leading industrial companies, subscribes to the philosophy of “Totally Integrated Automation” (TIA). This concept ensures users that automation equipment from the company’s vast portfolio of hardware and software will be compatible and therefore easy to integrate, helping customers lower their engineering costs. Now, Siemens is extending the concept of total integration to its automation software.

The first step of Siemens’ initiative is the release of the “TIA Portal”, an engineering framework that integrates multiple automation application in a single environment. TIA Portal is a new, intuitive development environment that integrates existing engineering tools with which automation users are already familiar. The first release of TIA Portal brings together the familiar STEP 7 tool for programming and configuring SIMATIC controllers. Integrated into this environment is WinCC, the configuration tool for setting up Siemens’ extensive family of operator panels. Finally, drives can set up and parameterized in the same framework with StartDrive, a configuration tool for SINAMIC AC drives.

Common Tags

The most obvious advantage of using TIA Portal is the universal accessibility of data tags. Tags created in any tool for any device are automatically and immediately accessible to other devices. If, for example, a user creates a new tag in the PLC to measure temperature, that tag is automatically created in the operator panel at the same time. This saves valuable engineering time compared
to conventional methods that require the tag to be created in each device. Should the user wish to modify that tag’s properties, he or she can change parameters from whichever tool is currently being used just by changing the view. In any case, the data is universally accessible.

For handling large amounts of data, the Portal makes it easy to create large data blocks and supports incremental naming of tags. Tag properties can be copied or changed easily for multiple objects simultaneously, and newly created data can be “dropped” directly into the configurations of other controllers or panels. The Portal ensures that the proper HMI variable, tag name, or IO field is created in the target object and creates a connection between the devices if one doesn’t already exist.”

The above description of the new software from Siemens may be an advertisement for the product but is a view that details the movement of software for ease of implementation. All software must move to this concept or an equivalent of this system. The student or engineer must be able to quickly solve the difficult problems of creation of logic and graphical interface and test the implemented system prior to launch in a factory.

**Hardware**

It is possible to add a new device in either Portal view or in Project view. Add a PLC device (CPU) or an HMI device in the "Devices & Networks" portal. If required, one can insert additional modules or network the devices, requiring the Project view.
An Example: Conveyor Control with Counter and Multi-Instance
For our process visualization with WINCC flexible, a counter and a multi-instance counter are to be added to the example of a conveyor control.
With the conveyor, 20 bottles respectively are always to be transported into a case. When the case is full, the conveyor is stopped, and the case has to be exchanged.
With button 'S1', the operating mode 'Manual' is to be selected and with button 'S2' the operating mode ‘Automatic’. In the ‘Manual’ mode, the motor is switched on as long as button ‘S3’ is activated, whereby button ‘S4’ must not be operated. In the ‘Automatic’ mode, the conveyor motor is switched on with button 'S3', and with button 'S4' (NC), the conveyor motor is switched off. There is also a sensor B0 that counts the bottles into a case. When 20 bottles are counted, the conveyor stops.
When a new case is provided, it has to be confirmed with button ‘S5’.
Assignment list
<table>
<thead>
<tr>
<th>Address</th>
<th>Symbol</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>%I 0.0</td>
<td>S1</td>
<td>Button manual mode S1 NO</td>
</tr>
<tr>
<td>%I 0.1</td>
<td>S2</td>
<td>Button automatic mode S2 NO</td>
</tr>
<tr>
<td>%I 0.2</td>
<td>S3</td>
<td>On-button S3 NO</td>
</tr>
<tr>
<td>%I 0.3</td>
<td>S4</td>
<td>Off-button S4 NC</td>
</tr>
<tr>
<td>%I 0.6</td>
<td>S5</td>
<td>Button S5 NO Reset counter/new case</td>
</tr>
<tr>
<td>%I 0.7</td>
<td>B0</td>
<td>Sensor B0 NO bottle counter</td>
</tr>
<tr>
<td>%Q 0.2</td>
<td>M01</td>
<td>Conveyor motor M01</td>
</tr>
</tbody>
</table>

Task
The conveyor control is to be operated and monitored using the panel. With the aid of the panel, the following requirements are to be met:
The operating mode is switched using the panel, and the respective operating mode is to be displayed on the panel.
The conveyor motor is started and stopped from the panel.
The case exchange is confirmed on the panel.
The transport of the bottles and the filling of the case is to be represented graphically.
Configuration
Under the configuration software STEP7 Basic, process visualization for the conveyor control is generated using the integrated WinCC flexible version. The process values are represented with screens and screen objects. Default values can be transferred to the control system using operator elements.
Communication between the operator panel and the machine or the process takes place by means variables via the control system. The value of a variable is written into a memory area (address) in the control system where it is read out by the operator panel.

The process visualization is saved and loaded into the panel KPT600 Basic color PN.

After the panel is powered up, the conveyor control can be monitored and operated. Ch 15 Human Machine Interface.
Inserting Panel KPT600 PN into the Project of the Conveyor Control

Project management and programming is carried out with the software Totally Integrated Automation Portal. Here, under a uniform interface, components such as the control system, visualization, and networking of the automation solution are set up, parameterized, and programmed. Online tools are available for error diagnosis. In the following steps, we are opening a project for the SIMATIC S7-1200, storing it under a different name, and adapting it to the new requirements.

1. The central tool is the Totally Integrated Automation Portal, which we call here with a double click.

2. Next, the project FB_Conveyor_Counter is opened in the portal view as a pattern for this program.

3. Now, First steps are suggested for the configuration. We Open the project view.

4. Now, first we save the project under another name.

5. Save the project under the new name ConveyorControl_KPT600.
6. To set up a new panel in the project, open the selection window by double clicking on
Add new device.
Under SIMATIC HMI, select the 6” display panel KPT600 PN. Place a check mark at Start device wizard. Then click OK
Then click on Next.
8. Under Screen layout, change the background color to White and remove the check mark at Page header.
Under Screen navigation we could set up a screen menu structure. For our example, the screen with the name Root screen is initially sufficient.
Then click on Next

As system screens, select the switch-over Operating modes and Stop Runtime.

Then click on Next.
Finally, predefined system buttons can be added. Remove all check marks.
Then click on Finish.
13. The WinCC flexible interface is opened with the root screen.
Project Navigation

The project navigation window is the central control point for project processing. All constituent parts and all available editors of a project are displayed in the project window in a tree structure, and can be opened from there.

Each editor is assigned a symbol with which you can identify the associated objects. Only those elements are displayed in the project window that the selected operator panel supports. In the project window, the device settings of the operator panel can be accessed.
Project Tree for WinCC/TIA
Menu Bar and Buttons
All functions that you need to configure your operator panel are located in the menus and symbol bars. If a corresponding editor is active, editor specific menu commands and symbol bars are displayed. Pointing with the mouse pointer to a command provides a corresponding QuickInfo for each function.

Work Area
In the work area we edit the objects of the project. All elements of WinCC flexible are arranged around the work area. In the work area, we edit the project data either in the form of tables (for example, variables), or graphically (for example, a process display). The upper part of the work area contains a symbol bar. Here, the font, the font color or functions such as Rotate, Align, etc.
Tools
The tool window provides a selection of objects that you can insert in your screens; for example, graphic objects and operating elements. In addition, the tool window contains libraries with assembled library objects and collections of picture blocks. The objects are dragged and dropped into the work area.

Properties Window
The properties of objects are edited in the properties window; for example, the color of screen objects. The properties window is available only in certain editors. The properties of the selected object are displayed in the properties window, arranged according to categories. Value changes become effective as soon as an entry field is exited. If you are entering an invalid value, it is color-enhanced. By using QuickInfo, information is provided about the valid value range, for example. In the properties window, animations and events of the selected object are configured also; here, for example, a screen change when releasing the button.
Details of the Object

**Operating Screens and Connections**

A screen can consist of static and dynamic components. Static components, such as text and graphs, are not updated by the control system. Dynamic components are connected to the control system and visualize current values from the control system’s memory. Visualization can be in the form of alphanumerical displays, curves and bars. Inputs at the operator panel that are written to the memory of the control system are also dynamic components. They are interfaced with the control system by means of variables. Initially, we are only generating a screen for our conveyor control.

**Root Screen or Start Screen**

This screen was set up automatically and defined as start screen. Here, the entire plant is represented. Buttons can be used to do the following: switching the operating mode between Ch 15 Human Machine Interface 85 Automatic and manual; starting and stopping the conveyor motor, and exchanging the box. The movement of the bottle on the conveyor belt and the fill level of the box are represented graphically.

**Connections to S7 Control Systems**
In the case of operator objects and display objects that access the process values of a control system, a connection to the control system has to be configured first. Here we specify how the panel communicates with the control system, and with which interface.

In Project navigation, click on Connections. Because of the settings in the hardware configuration, all parameters are already set.

The IP address has to be assigned to the panel also. By means of Accessible devices, read out the panel’s MAC address, or read it on the back of the panel.
Assigning the IP Address
After inputting the MAC address, the IP address can be assigned under Online & diagnostics. The panel has to be in the Transfer Mode in this case. Change the IP address to **192.168.0.5** for all applications.
Note
The IP address can also be checked or entered on the panel in the system control under Control Panel at Profinet.

Configuring the Root Screen
Clicking on the button “System screens” displays the system screen. We want to transfer the function of the button System screens to the function key. Select System screens and in the Properties window below copy the function Activate screen at Events Release
Configuring the Buttons Automatic and Manual
Drag a button into the work area of the root screen

ASSESS THE PROCESS BY TAGGING INDIVIDUAL ...