ANNA Inc.
Bringing Solutions to Power™

MAN-MACHINE INTERFACES AND THE ENGINEER

ABSTRACT

MMI Programming is no longer the domain of computer programmers. Software like Wonder-ware's InTouch® and Intellution's FIX® enable an operator or engineer to develop the screens. The advantage is a reduction in personnel needed for design, startup, modification, and troubleshooting of the MMI. Additionally, the engineer or operator has direct input into the look and development of the screen displays.

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Man–Machine Interfaces and the Engineer

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• SCADA • Man-Machine Interface (MMI)
• Data Acquisition • Programming • PLC

INTRODUCTION

Recently I had the opportunity to make a decision on the development of a Man-Machine Interface (MMI). Not long ago the decision would have been simple — assign the development and programming to a programmer. However, because of my background as an operator, I wanted an operator and engineer to develop the screens. Could an engineer or operator learn how to do the programming?

The Man-Machine Interface is becoming the new control room. In fact, in many plants they *are* the Control Room. Power Plant controls are evolving from manual valves, breakers and switches to complete remote control with loading and unit operation decisions made in the computer based on inputs. Most plants today are a blend of technologies. The level of automation is a factor in the early design process. The more a plant is automated, the higher the capital cost, and the lower the operational costs. The higher capital costs are the largest barrier to complete automation. However, I believe that when a full commitment is made to automation and virtual control panels, the cost will be competitive with conventional control rooms and data acquisition systems.

Many designs being produced today have a fully functional control panel and a Man-Machine Interface that mimics the operation of the panel. Are both needed? With the improved reliability and quick replacement of computers and PLCs this need is quickly being eliminated.

MMI DESIGN

The design of a Man-Machine Interface is critical to the operation of the power plant. This is the window for the operator into the workings of the plant for status and control. The information displayed and how it looks on the screens will depend on the operators involved. For a process that was manual and is being upgraded to automatic, the screens will be more user friendly to the operators if it looks like the equipment. An actual picture of the equipment and with the instrument values and controls superimposed on it will appeal to the operators. If instead the equipment is new or remote to the point where the operator doesn't need to know what it looks like, then screens that look like simplified Pipe and Instrument Diagrams (P&ID) or schematics are more appropriate. Organization of the screens must be developed with the operator in mind. The screens should be organized using simple operational logic, with an intuitive connection pathway. A programmer does not usually have the insight to look at the development of the screens from an operators point of view.

Who should design a Man-Machine Interfaces (MMI) program? The design engineer, the operator or a programmer? Improvements in programming software are reducing the question to only two — the engineer or the operator. The software available today is easy enough for an engineer to use. Just as typing was the domain of secretaries a few short years ago, MMI programming is not just for programmers today.

The decision was made; assign the programming to an engineer with operational experience. The engineer had to learn the MMI program, Wonderware's InTouch®, and how it interfaced with the Allen-Bradley PLCs specified for the project. While this decision may have appeared to be a great risk to some, it proved to be a good move. The company was responsible for the entire scope, so they were able to resolve in-house items that would have resulted in delays and additional costs.

The project was an addition of Two Diesel Generators with Heat Recovery Boilers. Our portion of the project was to design the control panels for the boilers and supply the Man-Machine Interface. There were five control panels total each with PLCs in a hot backup arrangement, totaling ten PLCs each of which communicate with the MMI.

PROJECT SETUP

The first hurdle for the project was the interface of the three major parts of the MMI; the PLCs, and the requirement to communicate using Ethernet. Ethernet caused a problem. Since the PLCs were to be arranged in a hot backup arrangement, the MMI must know which PLC was the primary. The Ethernet compatible PLCs had only been available for about one year. Existing installations similar to this one could not be found. Some were located that had some of the elements, but not close enough to provide the answer.

Looking at the problem from the PLC side, we had to find a way to change the IP address of the PLC (hot switching of the IP address) so the MMI would receive data from the "one in control" or primary PLC. To make this happen at the PLC level would require a co-processor and a dedicated digital input card, not to mention some"C" application programming in the PLC. The additional hardware and programming would have to be provided for each of the ten PLCs. This would be a very expensive method. There had to be a better way.

We looked at the problem from the MMI side. If the MMI could change its internal address on a global basis, maybe it would be able to perform the change over to the primary PLC. The first step was to establish communications with one PLC. The MMI program comes with DDE servers for most protocalls, including the Ethernet. We set up the TCP/IP and DDE and we were in business.

The next step was to find a way for the MMI to recognize which PLC was primary, and then swap all pertinent addresses to the primary PLC. It was determined that a script could be written in InTouch[tm] that would do just that.

The addresses of all inputs and outputs from the MMI were written to the first PLC. A fixed address was created to constantly look at each of the two PLCs to determine if it was the primary PLC. Then a script was written to perform a global change of the addresses to whichever PLC was primary. The result was a seamless (to the operators) transition between PLCs. An alarm was then created to alert the operators that there was a problem with the PLCs, or the ethernet communications.

MMI SCREEN DESIGN

With the setup installed and tested, design of the MMI screens commenced. The first step in design takes place on paper where informational order is developed.

A philosophy was developed for screen appearance and for layout of the screens. For this project, all controls on the local control panels were to be available from the MMI. With the consideration of Human Factors, the controls should be intuitive to the operators. And since this was a new installation, if the controls were different in the MMI from the local panel, the operators would have to be trained twice. To accommodate these considerations, the screens were developed with the following philosophy:

1. When controls were grouped on the local panels, the MMI screen would mimic the controls visually and functionally. This would apply to the diesel controls, and annunciators for all panels.

2. Auxiliary systems would mimic their respective Piping and Instrumentation drawings.

An overview screen was developed to give general information to the operator. The diesel engine, Generator, Heat Recovery Boiler, and Output breaker are shown for each of the two trains of the plant (see Figure 1). If any of the major equipment were to have an alarm, the picture of the equipment will flash. A click of the mouse on the equipment will bring up the detail screen for that equipment.

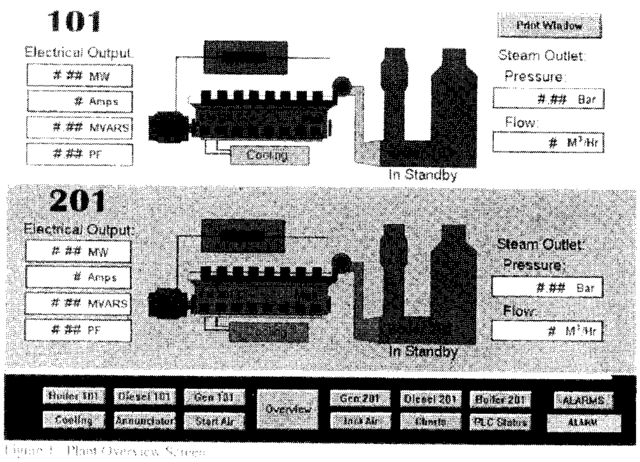
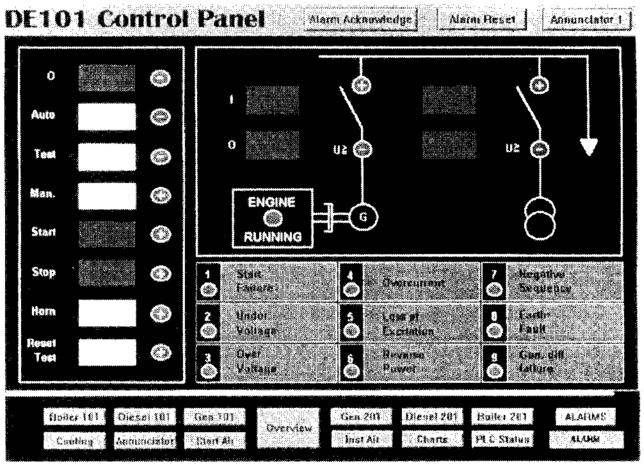


Figure 1. Plant Overview Screen

The second level screens provide details and control of the major equipment. They also provide indication of alarms in auxiliary subsystems. Links to auxiliary systems (third level) are provided for quick access. From these second level screens, links are provided to control screens, annunciator screens and alarm readout screens. All alarms are printed on system specific screens and on a general alarm list screen. The system specific screen has virtual recreations of the actual annunciator located on the local panels. The annunciator windows on the screen flash in the same way as the local panel annunciators. This keeps the information presented in an identical fashion which assists operator training and eliminates a potential for misinterpreting the information provided.

The controls for the diesel are pictorial recreations of the actual controls located on the local control panels. All indications and operator actions are identical (see figure 2).

Auxiliary subsystems screens are designed as a simplified version of the Piping and Instrumentation



Drawings. This layout maintains the operators continuity of information. Any alarm for the subsystem is displayed in accordance with its physical location in the plant. For example, a tank low-level alarm appears at the bottom part of the tank picture. Pumps which can be operated from the MMI are colored according to pump status; Red for running, and Green for stopped. Control of these pumps are by a mouse click on the pump which brings up a small screen asking "ON", "OFF", or "CANCEL." The two step process is user friendly and prevents inadvertent operation of the equipment.

An important item to be concerned with is control of variables. Numerous methods are available to the programmer: slide controls, raise and lower push buttons, and direct numerical inputs to name a few (see figure 3). The choice is important and depends on the variable. For example, an MMI at a hydro plant we know of used direct numerical inputs for setpoints. During a start up, the operator typed in a number that was off by one decimal place (1000 vs. 100). The result was that the plant attempted to perform as the operator asked, went beyond its operating envelope and tripped.

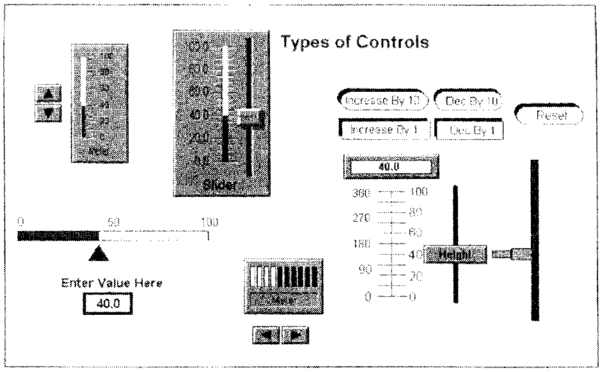


Figure 3. Examples of numerical output possibilities

A better control for this situation would have been to use raise and lower push buttons that changed the numerical output. Also, a limit on the range of numbers that could be inserted would have prevented the trip.

Two limitations of the MMI program were encountered. One was the inability to print alarms and trips in different colors to a logger printer. The other was report generation. There are add-on programs that could accomplish reports, but in this case the operators did not have experience with computers. To provide the needed reports, screens were developed that could be printed on demand and automatically on a predetermined schedule.

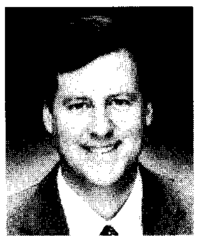
THE ENGINEER AS A PROGRAMMER

By using an engineer with operating experience to perform the programming for this project, we gained in-depth insight into:

- What the software can and can not do.
- How improved software opens the door for engineers and operators to perform programming.
- The differences of looking at a project from the user's viewpoint vs. the programmer's.

The engineer's first arrangement of the screens was clear, readable, and intuitive for others to understand and use. Since the engineer was also responsible for the design of the control panels and for the overall operation design of the boilers, the reduction in the MMI programming time made up for the time required to learn how to use the software. Another benefit is that fewer personnel are needed for plant startup.

Now that we have proven the value of using engineers for programming, I am looking forward to the next project where we can fully utilize the lessons learned. The result is a lower cost to the customer, a higher quality product, and more operator friendly interfaces.



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Mr. Haaland has over seventeen years of experience with power plant mechanical, electrical and control systems. He has provided design, maintenance and construction engineering services for nuclear, diesel, cogeneration, combustion turbine and steam turbine power plants.

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