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Movicon.NExT™

Best Design Practices: How to Create High Performance HMI to Enhance Operator Efficiency

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Abstract

Operator performance has a major impact on overall operational efficiency. To assure efficiency, it is essential to have effective controls, systems, tools and training in place to enable operators to quickly and correctly handle both normal operations and abnormal situations. This requires optimal alarm management, control system performance and, very critically, human machine interface (HMI). High performance HMI is defined as an operator-oriented interface structured for maximum efficiency, speed and ease of use. This white paper highlights how modern, smart HMI technology, combined with best design practices based on the ISA-101 standard, help create flexible and effective solutions that enhance operator and plant efficiency.

Introduction

When SCADA interfaces were first introduced, there were no guidelines or standardization for graphics. Although there were common HMI depictions, these were often ineffective due to factors like inconsistency, improper use of color, and a lack of visibility to trends and equipment health information that were essential in enabling operators to quickly determine how processes were running. As computing processing power increased, so did the available graphics, but poor design practices persisted, failing to support operators' needs. Often operators could not easily tell what was running or any abnormalities that had occurred.

As a general rule in HMI, poor graphics result in poor operating practices. Human error is the leading cause of safety incidents in industries such as oil and gas production, refining, chemical, power, mining and rail, and the cost can be catastrophic. For example, in the Texas City Oil Refinery disaster in 2015, which resulted in 15 people being killed, 180 people injured and $1.5bn of damage, poor HMI was cited as a significant contributing factor, with operators unable to tell from the HMI that they were continuing to feed fuel into the fire. Providing operators with the tools to make informed decisions is essential.

ISA-101 standard

In 2015, the ISA-101 HMI Design Standard was published. This standard lays out the minimum requirements for HMI displays, including their design, documentation and management of change. Very concise, ISA-101 provides overall design guidance and a workflow for developing and managing HMI systems, including change management. For truly effective

HMI design, however, there needs to be a focus on operator efficiency and creating screens for situational awareness and operator tasks. In addition, companies need to go beyond ISA-101 to train operators to use the HMIs. Facility owners must develop a clear HMI philosophy document and style guide for the HMI system. To further improve efficiency and decrease human error, reusable software toolkits of screen elements should be developed. The goal is to produce a true high performance HMI.

High performance HMI

The aim of high performance HMI is to provide simplified interfaces that speed operator response time, improve problem and alarm resolution, while reducing errors. Instead of portraying a real-world representation of the machine or process, operators need information reflected in a manner that is easy to scan for anomalies and identify areas that require further investigation and action. High performance HMIs incorporate application-specific and personalized screens that help operators achieve a purpose, spend less time searching and navigating, and allow them to make better decisions faster. Keeping the HMI simple also makes it easier to train the next generation of operators. An effective interface is easy to learn, leads to faster reaction time, and enables safer operations and higher productivity.

Basic concepts for designing high performance HMI

When developing a high performance HMI, one of the main principles is using moving analog indicators instead of just numerical displays. The analog indicators will display the span of an instrument, show abnormally high and low values, and high-high and low-low process values. With these analog indicators, operators only need a quick glance to understand the status of the process. Likewise, making trends available should be a top priority.

Other basic concepts include but aren't limited to:

- Use of a tight scale makes change immediately obvious to the operator without the need for keystrokes.
- The use of color is fundamental to high performance HMI.
  - Colors need to be used consistently.
  - The background color should be light gray, helping to reduce glare and operator fatigue.
  - Foreground colors should be kept to a minimum and used sparingly to indicate abnormal situations and to draw the attention of the operator.

- Line thickness should also be consistent and styles restricted to solid, dash and dots.
- Arrows indicating process direction must be kept to a minimum to decrease confusion.
- Process equipment and vessels should be drawn in 2D, avoiding shading and gradients.
- Avoid overcomplicated equipment drawings, with unnecessary detail, such as inner workings. Focus should instead be to display only elements that enable the operator to know what is happening.
- Process flow should be consistent across screens, and in general, flow from left to right, vapors up and liquids down.
- Minimize the use of static text that names or describes objects. Keep abbreviations consistent.
- Live data should be depicted differently from static text with a different color (usually blue).
- Live data should have units of measurement shown.

Fundamentals of designing high performance HMI

User interface (UI) optimization focuses on the look, feel and functionality of the HMI, while user experience (UX) optimization focuses on maximizing the positive experience of the operator when using the HMI. Both are very important to the overall success of the HMI design. When both work together—a simple enjoyable experience complemented by a good look and feel—this creates the ideal operator interface.

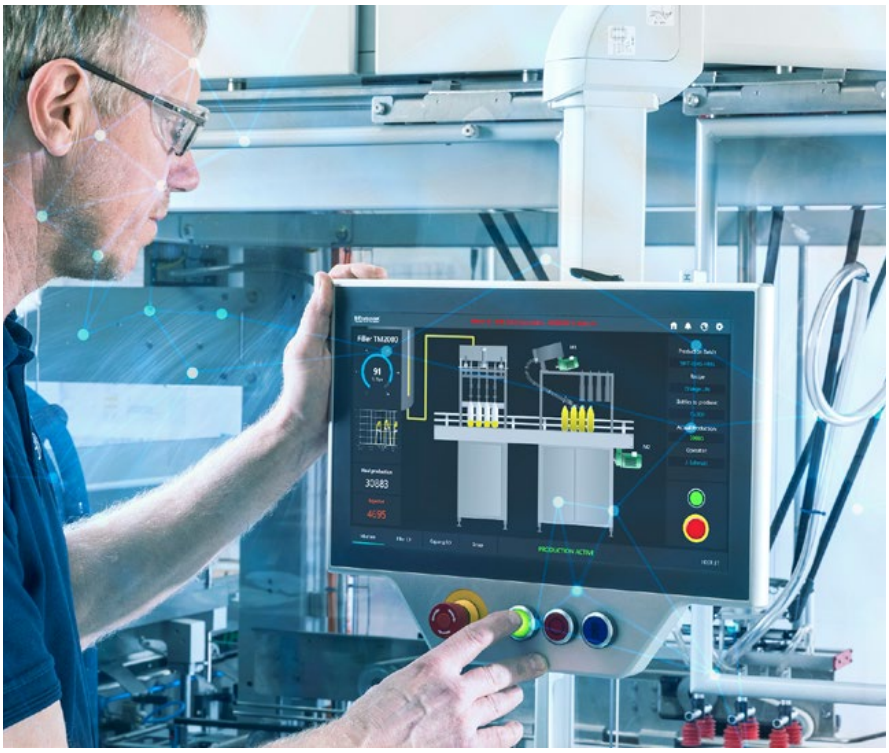
Designing the HMI with the end user (operator) in mind requires focus and understanding of how an operator monitors and controls the process, and what their needs, limitations and expectations are. The experience should be intuitive, as simple as possible and focused on real needs, not “pretty pictures.”

In designing for the intended user, the operator, it is not necessary to try to accommodate the needs of others, such as supervisors, engineers and maintenance personnel. The goal is for the operators to quickly spot abnormalities or devices that need diagnosis, without the need for trained maintenance engineers to interpret information.

When implementing an HMI on a brownfield site (overhauling an existing HMI) there may be resistance to change since it always seems easier to stay with the known. That’s where the HMI philosophy and style guide come in. These documents can explain the benefits of high performance HMI (perhaps in

workshops) and the potential benefits to the operators and the company. Creating an HMI philosophy document lays the groundwork for the design of the HMI and provides guidelines to ensure continuity across multiple control solutions.

The style guide is a detailed document specific to the project that includes all aspects of screen layout, including color, line size, font size, objects for pumps, valves and tanks, and navigation elements. The HMI philosophy document and style guide help to maximize the control system capabilities and improve the chance of project success.



The style guide also documents and helps to standardize screen objects used when creating displays. Each object, designed according to ISA-101, has its own function in the control system, and will be used without modification, across all displays. The objects are contained in a library, which enable the control system to be designed using a drag and drop environment. This development methodology leads to reduced errors, shortened development time and lower costs, as well as increased profitability.

Use of color and graphics

Proper use of color is paramount, with colors used primarily to attract operator attention. Overuse of red or green in everyday graphics to indicate running/not running can make it hard to see abnormal events. Ideally, color should be removed from graphics in favor of grayscale and then used to indicate the abnormal, rather than normal operations. Color blindness is very common, and color changes tend not to be detected well in peripheral vision, therefore color alone should not be used to differentiate an important issue.

In HMI for production monitoring and control systems, graphics need to be simplified because there can be so many tags used in the screens to provide an overview status of the entire plant. Over time, these screens evolve and greater complexity tends to be added to the point where clarity and ease of use starts to be erased, especially for new operators. Moving to very simplified piping and instrumentation diagrams (P&ID) for skids and processes is important within the process and supervisory applications.

Data is not information

Individual figures on their own do not support operators well, especially inexperienced operators who may not be able to interpret the data. It is important to provide a scale, desirable operating range, alarm range and indicator as to good, normal or poor performance.

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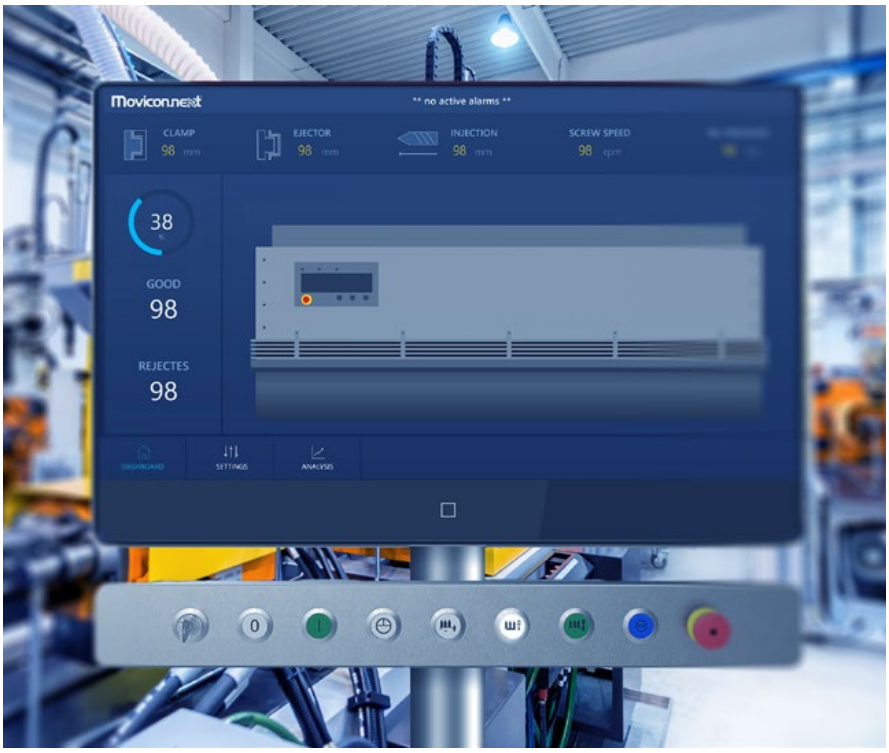
It is also important to embed information into the HMI, where operators can drill down to gain detailed explanations of alarms, potential problems and solution steps. Alarm indicators should be shown in multiple ways, with different colors, shapes and text. Always providing visible trends rather than separate trend screens or pop-ups keeps operators in better touch with operations.

Modern operator interface technologies

High performance HMI design helps to create interfaces that increase operator efficiency, but these design practices are enhanced further by the latest operator interface technologies. For example, WPF (Windows Presentation Foundation) is an open-source graphical subsystem developed by Microsoft that is ideally suited to HMI and SCADA applications, especially if there is a requirement for more than just static images and text. One key advantage of using WPF is that it offers much greater flexibility and improved visual aspects, with the ability to create applications that are screen resolution independent. WPF objects are easily rotated, sized and scaled without any code, ensuring that applications look good in 600 x 800 format or high definition without having to completely rebuild the application. In addition, these objects create not only more engaging applications,



but help the HMI designer to do so in a shorter period of time, with much less effort and coding.

Web-based HMI systems

For those users looking for a cost-efficient HMI solution, without unnecessary complexity, web-based systems provide the functionality they need, but with the economics of a web browser. Web-based HMIs are accessed via a web browser on any device with internet access and allow users to monitor and control machines and processes remotely. Web-based HMI systems are now suitable for applications requiring responsive animation and real-time control, with the ability to deliver sub-second response times and seamless integration with enterprise-wide systems. They enable all participants in the manufacturing cycle to have unprecedented access to vital plant production information. For example, Emerson's Movicon™ WebHMI dramatically extends today's HMI performance capabilities using advanced web technology to deliver superior connectivity and scalability for Web HMI and cross-platform applications.

Web-based systems run on any web browser, requiring no client licenses, software installations or the need to set up communication configurations. Even for organizations with greater IT resources, web-based systems

are more familiar and easier to embrace. Web-based systems leverage standard and proven web security techniques as administered by IT departments.

HTML5 mobile-ready HMI

An HTML5 mobile-ready HMI is an HMI display built on HTML5 technology and is thereby accessible on mobile devices and computers, without needing to duplicate the display configuration on the mobile platform. It provides display portability and ease of use to a facility's HMI plan by showing control room displays on a web browser. This enables personnel to see the same data and graphics securely as operators in a facility remotely, which can help ease collaboration between control room personnel and remote personnel.

With an HTML5 HMI, any device with a browser—such as mobile phones, tablets, laptops, and operator workstations—allows remote or field users to see the same information and graphics as they would in a control room. The ability to view this material on-demand easily and securely from a browser enables people to make informed decisions at any time and from anywhere. To limit risk, mobile access to operations data can be limited to read-only, with cybersecurity built-in, by enforcing strict user permissions or ensuring only authorized personnel can access

specific data depending on role and other factors such as location. Additionally, access from mobile devices can be limited to connectivity from business networks that are isolated from the control network by firewalls.

The widespread adoption of mobile devices and the need to provide greater access to operational data both inside and outside of an organization, is changing the demands on human-machine interface and supervisory control and data acquisition. Web and browser-based technology that can support industrial applications is presenting opportunities to expand the functionality and accessibility of HMI.

Extended access to the HMI/SCADA system, however, increases the focus on security. Many companies don't allow SCADA applications on smartphones due to security concerns, but tools are available that can allow users to get data from different applications effectively and securely. As with other cloud-based applications already used by most organizations, such as email and document sharing, single sign-on (SSO) user authentication can be used with SCADA, which enables individual users to gain secure access. Identity verification can then be performed using two-factor authentication, which requires

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credentials and a further step such as a PIN being sent to a smart phone.

Web technologies such as HTML5 and new visualization tools in modern HMI/SCADA applications enable industrial applications to be created that run natively on any mobile device and web browser. To enhance usability, the applications have mobile-responsive designs and present data in different form factors, dependent on the device.

HTML5 language is used to define and structure content on web pages and allows users to build a single application that works well on different types of devices.

Augmented reality

As technology continues to evolve, so does the concept of HMI, and the integration of augmented reality (AR) is redefining the human-machine interface. AR technology has been introduced to enhance the user's physical world with computer-generated content. By using AR, it is possible to add information in real time to the surrounding environment, which proves extremely helpful in evaluating status to improve decision-making.

AR allows operators to use technology integrated with standard HMI viewing tools to perform actions needed within various stages of the process, improving production efficiency,

reducing the risk of errors, and minimizing production or maintenance downtime.

When operators are informed about any plant problem or requirement, AR allows them to go on site, receive the relevant information in real time, and perform guided step-by-step operations and set-ups directly on the spot.

The introduction of wearable devices has increased the range of applications and created new operational possibilities. Having the opportunity to wear HMI while working in the field or on the plant floor leaves operators' hands free to perform tasks such as manual maintenance, to keep processes constantly under control, and act immediately and accurately based on the circumstance of the production process.

Augmented reality HMI

Emerson is one of the first companies to offer AR solutions for HMI/SCADA. AR is integrated into Emerson's Movicon.NExT™ HMI/SCADA platform, which reduces implementation costs, and by means of wearable AR devices, operators benefit from simplified process management and real-time information relating to the equipment or process they are working on.

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Applications are provided that support Android smart glass devices and HoloLens based on Windows 10. The wearable devices can display any kind of real-time and historical data or information, including set-up, maintenance, guidance, code bar and other functions. In addition, operators can now dialog vocally with a machine, ask information and give commands, as well as interact directly with the system using hand gestures to control and set up processes. Furthermore, the machine can ask the operator to execute the necessary commands and give step-by-step instructions to carry out on-the-spot manual operations as needed to save time and avoid mistakes.

The AR HMI technology also uses a video camera and artificial intelligence to recognize equipment or parts of the plant. The technology will operate on any mobile device with a video camera and HTML5 browser and will automatically display HMI project windows that contain the corresponding relevant information. This enables the operator to instantly obtain all the relevant information they need, making the management of complex plants much easier.

Conclusion

Today's high performance HMI goes far beyond pretty, impressive graphics, to literally maximize the efficiency and accuracy of operators. This efficiency, in turn, impacts operation productivity, reduces errors, avoids shutdowns, and increases profitability. Despite fear of change, the ease-of-use and simplicity of high performance HMIs, such as the Movicon.NExT platform, wins over operators quickly and produces fast results. Cost effective and easy to implement, high performance HMI is a small investment in a big and positive change.

For information on Emerson's Movicon software platform for developing high performance HMI, visit **www.Emerson.com/Movicon**