High Performance HMI

Concepts from “The High Performance HMI Handbook, a comprehensive guide to maintaining effective HMI’s for industrial plant operations”
by Bill Hollifield, Dana Oliver, Ian Nimmo & Eddie Habibi
Published 2008 by PAS
Before I begin, I would like to include a general disclaimer regarding this presentation.

While I will be covering a lot of material aimed at broadening your knowledge on this topic, this information is for educational purposes only. Before acting on any information presented today, please check with an expert in the subject matter to ensure the application of any information shared in this presentation is appropriate to your specific business situation.

Thanks .. and now, let’s move into the presentation ...
This book is generating some discussions around how HMI graphics are built. I have been asked by a handful of companies “do you conform to the High Performance HMI standards”? The short answer is “yes, our systems can build these kinds of graphics”. But maybe the question is deeper than that, maybe we need to re-think why we build HMIs, for whom are we building them, how we teach the editing tools?
Statue: “The Thinker” by Auguste Rodin

Decisions are based on the information that we provide the users. It is critical that we provide the correct content for the situation and for the right person. I was introduced to the concept of a “consumer” from a long-time expert in the HMI/SCADA world, Mitch Vaughn. We need to think about the consumer of the information. Is this an operations screen? Is this a maintenance function? Is this a manager’s view? Furthermore this is beyond the job title but needs to leverage today’s technology to provide the best information, but not throw today’s technology at the user because you can do something slick with the product. Most HMI/SCADA systems have multiple consumers. Our goal is to find the best way to convey the information for your consumer.
From the picture, we see that this guy is dead. Funny, we can’t see or read any of the details, but yet, we all know that he is dead... the little white triangles are at the bottom of every bar graph... must be dead.

These are simple graphics, they convey a lot of information and as operators are used to looking at their screens, they already know which bar is for Temperature, etc. The bottom line is: from a glance we get a lot of information.
Movie, CGI, Video Game... the computers today can render a dizzying array of colors, hues, and animations. HMI systems can do the same with 65 Million colors, shading, hues, etc. But is that what we want? Certainly, the systems are capable of building movie-grade pictures given enough development time, but do we need flames that dance, water that shimmers, and rain that falls?

Screen from Warcraft
Let’s make the screen as confusing as possible and stuff as many pieces of information on a panel.

This is not unlike 100s of screens I have seen over my career. Operators know exactly where to look, and can click on various setpoints to make adjustments. Do the operators need to know that they are manipulating V23, or do they just open the dump valve after the batch. We need to separate the information which is critical to the operations from the maintenance functions. The maintenance guy needs to know it is valve 23, but does the operator need that exact piece of information every, 24x7x365 staring at him.
WOW, let’s choose colors that are pleasing so we can look at the screen all day! Maybe this screen was designed to be viewed immediately after lunch? Why is everything in manual? Maybe the background is yellow because there is no automation due to everything being in manual and it is to tell the operator, “watch out”.
Lots of data, but is it helping you?

This screen conveys a lot of data, but not a lot of information. Is the timeout of the device an operations value, or a maintenance detail? Think about the data you present and why now? Just because it is the next value in the PLC memory address space, does not mean that it must be displayed at the same time as the flow of the items. It says “SCADA Maintenance” at the top, so if this is a maintenance screen, why the load balancing information.
Concept from the book, why do we do control by alarm? This is a fun example of what may have been my last flight out of Chicago during thunder storms. The point is clear, if the only information we give the operator is the alarm, this is how he or she will approach the operations of our process.
PLCs and other field devices provide wonderful digital data for our HMI/SCADA system. Our software is designed to pass on this digital information to anyone who wishes to look at it. This is exactly what our sensors have reported and now I report it to you.

Over the next few years, your operators can probably remember that 83 is just 2 degrees into the warning area. But the new operator is not sure if that is the upper warning or the lower warning?

So, why do we have warnings? The situation is not critical, usually the warning is the point at which we remind the operator that he/she should look at the entire situation and get ready for a setpoint change.

This is the data we would provide if we want our flight to be like the previous picture, bouncing between the alarms rather than anticipating them.
Here is a hybrid of the digital and analog world. Sure, we have the detail of the data coming from the field devices, but the bars below the output fields give us a sense that there are high warnings and high alarms. The reference vertical color bars give us an idea of the warning and alarm values and we can anticipate a change to come.
Our brains have been subjected to the digital world for only a few decades! All the rest of history, we looked at physical things and the world is analog.

Autism may allow people to look at numbers differently from the rest of us. Maybe they don’t see the numbers at all, they see some sort of “spacial” thing that allows them to calculate things in a different way. Some experts think that they see numbers occupying specific positions in space. They also have characteristic colors, textures, movement, sounds and, importantly, shapes. We call them “Savants” because they can do amazing calculations in their heads and they cannot explain how they do it. The rest of us look at a number, evaluate what it means in the context and then decide if it is “correct”.

“Synaesthesia and savantism”, from Wiring the Brain, June 21, 2011.

Slide text reference “Neuron” January 17, 2007
Slide text reference Wellesley College “Study reveals insight into how brain processes shape, color”, in Science Daily, Dec 19, 2013
Most modern race cars use HMI dash boards. Now, drivers are suffering from the same issue we have, too much data, not enough information, or not information fast enough.
This is an advertisement for a gun sight. This vendor understands that the brain likes organization rather than chaos and built a gun sight that allows the shooter to line up the shapes to complete the triangle.

“The XXXXX Sight is designed to be compatible with the brain’s tendency to complete simple geometric shapes”
[Describe this screen]

This screen is very similar to our Star Trek reference. “Jim, he not dead yet!”

Light blue: desirable operating range
White: alarm warning range
Grey: alarm range
Black: automatic shutdown value

Notice that the alarm is not just a color, but also a shape. This can help operators who have difficulty with color differentiation.
This is an improvement on the bars from before. Maybe we can also inform the operator what the values have been like in the past hour? Sometimes they may need to toggle the actual value to see it. Do we know the “tendency” of the value?

This is our first visual information vs. data. There is a lot of information here and it takes a bit of effort to capture and store that data to display this information.

Maybe the operator knows that the third bar is pressure. Maybe we can turn off the labels?
Again, the brain is designed to decipher shapes. To know if this is a good temperature profile from the numbers, you have to study them for a moment. There is no way to glance at the numbers to know. But, if you display as a shape, the brain knows in a split second if the values are consistent.

This type of tank chart is a bit tricky to make, this is not a standard line or trend function. WinCC SCADA products can build these types of information objects, but they are not part of the libraries.
This quote is from a customer for water treatment. He believed that if you understood the process, the trends would tell you what you should be doing to anticipate your next move.

This set of trends is from CERN using our WinCC Open Architecture product. This is from a training document to show operators what to look for in a particular process. The circled comment is great: “If you see this, call someone!”

Our brains can see anomalies in the datasets. If this were a screen full of current values in a table, would the brain be able to see that there is something wrong with the Iron 55 spectra value?
This is a great example of a screen showing a tank system with valves, pumps and levels. Each tank has that cute bar graph showing the level of the tank.

Are the tanks filling or draining? I guess we could study the valve positions and the colored pipes to evaluate if the process is running correctly... who cares! There is no RED things on this screen!

WAIT !!! There is a very small exclamation symbol by one of the values. Did you see it?

Is this a lot of data or information?
Embedding the trend inside the tank, now you have the current level as well as the history. Now you can anticipate the values in the future and make control changes to manage it better. Markers show min and max values, inside dashed lines show alarm limits. Again, this is an example of providing information about the process or the equipment not just the data.
While we can see some sort of change emerging in this trend for the red data, the real information is in a trend of the average. Here we can plainly see that our output is “tending” lower. We can also see that a blip like the bad sensor read that dipped very low for one sample, did not affect the average that much.

The blue line represents a better view of the process. Sometimes we display trending that is also data and not information. This RED plot is a lot of noise, but in the mess of that data, the running average gives us information that we can use to make decisions.

The WinCC SCADA packages support this type of calculation and trending.
Black background was a necessity for old CRT monitors. We used BLACK so that we avoided burn in of the objects into the phosphors of the screen.

Maybe there is a bit too much RED on this screen. Sure when the subject breaths they get a red circle, I guess that is probably important. When the heart beats we get a red circle... but those are still what we would expect for Dr. McCoy’s patient. Maybe we should reserve the color red for something really important?
Reference: Tecview by auteco

So, why do we blink things? Answer: so we can draw attention to them.

Why do we spin things? Answer: in the real world they turn when ON, so we should turn them on the screen?

All of these techniques to bring attention actually overwhelm the operator. When should he really look at something?
Notice that we are saving the color for something really important.

In the case of alarms, we are including a shape with the color. The brain then uses both of the attributes (color and shape) to evaluate the severity of the situation. These decisions are made quickly, then additional information can be analyzed to determine the proper course of action.

You will also notice that the values that have red and magenta background are harder to read. Just when the data is critical, we cover it up in a color that is hard to read!
Look at some of these details. Yes, there is a “mimic” of the process as a picture, but all of the real control information is in the bars that we have seen before. Notice that the bars have some additional functions like removing the values or normalizing the scale? Look at the colors, anything on this screen critical? Can the operator open details?

Trends plots are not combined unless they are related. Three trends, with different min/max legends, very little confusion here. Same time scales.
ISA November/December 2012: “The high performance HMI, Process graphics to maximize operator effectiveness” by Bill Hollifield

A bit fuzzy from the capture, but the point is you can glance at this and know what needs a further look. The trends show related things on the same chart so that the brain can visually compare the history and make an educated guess as to the future values.

Those alarms look important, now the operator can bring up details to make an informed decision. Notice how much information about the process is on this page, the operator can see a lot about what has happened, what is happening and where this is going.
Book page 101

For this High Performance screen we see a mix of all that we have see before but on a very dense screen. That CRM on Reactor 2 has been running down in the lower part of the target operating values for a while. Maybe we should have noticed that earlier?

We are also introduced to a “polar” chart. This is just an x-y chart that compares multiple values without time as an axis. These polar charts take a bit of time for operators to understand that the shape of the plot means a particular situation. There is an entire discussion about this in the book in Appendix 3 as “Enhanced Radar Plot”.
The resolution on today's handheld devices is great. My phone is full HD 1920x1024, but that does not mean it displays the same HMI/SCADA screens my computer displays. As you can see, there is a tree navigation on the left, so small that you cannot choose a particular item with your finger, maybe with a stylus. The numbers on the display are just too small to see.

Yes, this SCADA support pinch to zoom, so you can enlarge the screen to navigate and see the details, but that is not very user friendly and users will not like that for every screen and every navigation.
While we think we need the same level of detail for mobile devices, we should think differently. The mobile user is a different type of “consumer” of the information. This type of user needs a quick look at the world with the ability to look at details, but the main screens should be bold, easy to click and navigate.

The screens for Mobile Use might even be a completely different type of project in the graphics. The WinCC SCADA packages allow for different entry points into the navigation making it possible to build the User Interface for the computer control room and the mobile devices in the same project.
The ISA organization provides great resources and this will be a major release for our industry. This goes beyond the concepts in the book, but addresses things like alarm enunciation and navigation concepts. Early versions are available now, but the release of this body of work should be available
I have been in the SCADA industry since 1988. We had 16 colors and edited graphics by pixel manipulation. Today’s vector graphics, web objects and style sheet driven objects are extraordinary. I have seen vendors produce libraries, only to find that the customer wants just one little change. Everyone has a project with defined requirements and they usually must be met to the letter. It is better to learn what a product can do, leverage the strengths of the features and build your libraries to match the target world in which you live.
Questions

Todd Malone
Senior Consulting Engineer

Siemens Group: HMI CoC

Email: todd.malone@siemens.com

Book: Amazon – "The High Performance HMI Handbook, a comprehensive guide to maintaining effective HMI for industrial plant operations" by Bill Hollifield, Dana Oliver, Ian Nimmo & Eddie Habibi
Published 2008 by PAS

ISA101 HMI standard nears completion