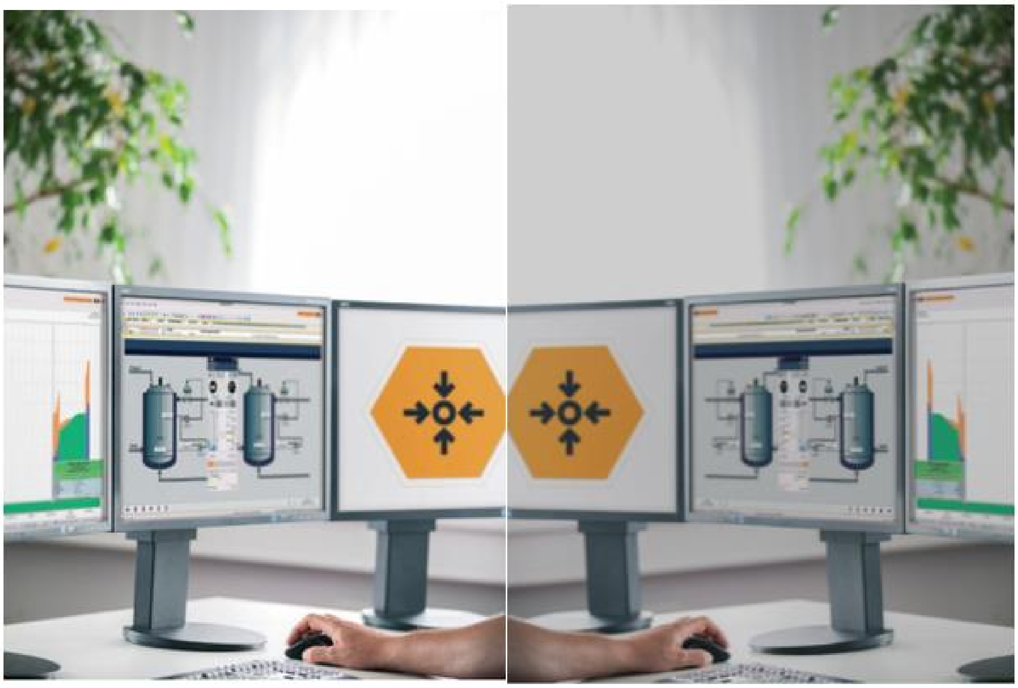
High Performance HMI Rules & Principles



Introduction

The Consortium under the leadership of Ian Nimmo, the Program Director, and a formal Honeywell Senior Engineering Fellow investigated best practices and missing technology associated with Abnormal Situations in the Manufacturing Industry. Back in 1995, the Consortium identified that the industry had evolved their graphics based on early computer technology that was very limited in capability and the industry had adopted many bad practices based on these limitations.

ASM vs High Performance HMI

During the transition from these bad practices to ASM best practices, the industry has been presented with two names, ASM Graphics and High Performance (HP) HMI.

You may say, "I am confused what is the difference between ASM™[1] Graphics and High Performance HMI graphics? That is a great question and one that requires some history. ASM

[1] ASM™is a Honeywell Trademark

comes from the Abnormal Situation Consortium which is a research group headed by Honeywell Inc. and a group of their top customers.

Legacy comes at a cost

One of the outcomes of this technology was that graphics were based on black backgrounds which conflicted with the room lighting promoting glare issues and that very bright colors were over used in the design of the graphics. Resulting in operators turning the lights off and sitting in the dark day and night impacting their ability to be alert and to adapt to 24/7 shifts.

Color Coding is important

No color coding led to many errors and loss of situation awareness. Simple coding of important information such as alarms was lost in the plethora of bright colors and not reserving colors like Red and Yellow only for alarm indication.

Some graphics had used the color Red for multiple codes such as closed valves, stopped the pump, heating or hot and much more. One customers graphic I discovered the color Red was used to code 13 different items. Hence, the graphic was covered in red during normal operations and did not allow the differentiation of a major**abnormal** event. Flashing was used as an eye catcher. Unfortunately, it was not always reserved for abnormal events but to indicate movement. One example was rotating fan blades. Unfortunately, the blades flashed regardless of the operation which defeated the intent of the flashing representing running.

ASM identified best practices

The ASM consortium identified best practices from organizations such as NASA on the use of color and internal consortium expertise to develop guidelines for the industry, unfortunately, initially, Honeywell held this document proprietary to consortium members only. They had released the wisdom and knowledge of the consortium regarding alarm management to EEMUA (191) for publication but blocked the release of the consortiums knowledge on HMI design. However, word and black leg copies got out, and ASM became a key phrase for HMI design. Unfortunately not all the understanding of the consortium's research was transferred with the terminology ASM graphics and soon a big push back from the industry after operators complained the graphics were bland and hard to identify equipment status and ASM was getting a bad wrap.

Original intent

The missing elements in the design and the original intent of the ASM consortiums research were to make it easy to read normal information and make abnormal or Emergency information pop off the screen, reducing the human error and loss of situation awareness. Many issues existed from operators getting tunnel vision and missing the big picture. The consortium addressed this by changing the loss of the big picture in the control room which was once there before the replacement of large panel displays.

A new hierarchy was proposed introducing 4 levels in the hierarchy, level 1 overview, level 2 unit view, and operations control page then level three detail view which is very much what the industry was using. Finally, a level 4 which represent more detail or diagnostic information which included trending and alarm summary data.

What went wrong?

None of the supposed "ASM" displays being developed by uninformed developers had this hierarchy, the displays were just a blandchange the background graphic from black to gray and got rid of all the colors and just use color for alarm condition so under normal operations information was hard to find and difficult to navigate. Not what the consortium recommended.

A new direction was required, and the EEMUA 201 guideline was not hitting the spot for the industry, it had the correct content titles but lacked detail and examples that the industry could emulate. Honeywell never made the research information available to EEMUA and did not provide detail content which would have raised this document to the acceptable design guide the 191 alarm management document has achieved.

Good news a new book

Together with PAS, Ian Nimmo produced the High Performance HMI Handbook using the knowledge of the consortium and personal research and many implementations to address the short comings in the industry and promote the original intent of the consortium's research.

The name was changed as ASM is a Trademark of Honeywell, and we wanted to imply that if the rules are followed the result would be an improved performance by operators. Research had shown significant improvements in an operators ability to detect a problem before an alarm state was reached, better formation of data allowed easier diagnosis of the cause of the abnormal event or process deviation and a significant reduction in the time to respond and correct the event. Simulations were done using the existing low-performance black background bright color graphics and new true ASM graphics and HP HMI graphics and the use of a simulator to test the operator's ability to detect, diagnose and respond to an abnormal event.

Some performance improvements through good design

If done correctly the graphics would significantly improve plant start-ups, identification of an abnormal event and be an excellent tool during shutdowns.

Over the last few years, ISA has been developing standards and guidelines in harmony with these guidelines; it has been very challenging for the committee based on all the different industries represented and a wide level of differing views not supported by formal research.

They have achieved an excellent life cycle model and identified the requirement that a company should have an HP HMI Philosophy providing guidance on what the rules are for the development of good graphics. A style guide which explains to a developer what the philosophy interprets into in the style of a specific automation vendors system (DCS), (SCADA), etc. Finally, the ISA 101 discusses the need for a toolbox or object library which documents the graphic object like pumps, valves, level indicators, vessels and other instrumentation objects.

So what is an Object Library?

Many vendors have developed or purchased object library's and made them either optional or part of a standard library used in the development of graphics. Some companies still choose to develop their objects to either replace or complement the vendor'slibrary, but they do not document them to the standard called for in the ISA 101 standard.

A good Object Library is a collection of software objects used in graphics to represent instruments, equipment

The introduction of a disciplined approach to change (MOC) for changes to graphics has introduced something that had caused many issues in the past and a new level of professionalism.

Delivering a Return On Investment (ROI)

Today, we see some good examples of control systems with High Performance graphics and the development of compliant level 2, 3, and 4 graphics have improved. Unfortunately, we do not see too many good examples of level 1 overview graphics.

It is hard for many applications to condense their overview into a single desktop monitor display, especially a refinery that an operator is monitoring multiple operation units. The solution is to introduce large screen displays and in some cases multiple forming a video wall to display the overview. Many fail in the development of this display by trying to use the same information that is a level 3 detail display and trying to use it as an overview by adding additional information.

The information should be an abstraction of the most relevant information that can indicate the health and function of the units under control. It should be capable of displaying all the relevant Highest priority alarm information and certainly all Safety Critical or Related information. It should also gather Key Performance Indication (KPI's).

Critical Action and Decision Evaluation Technique

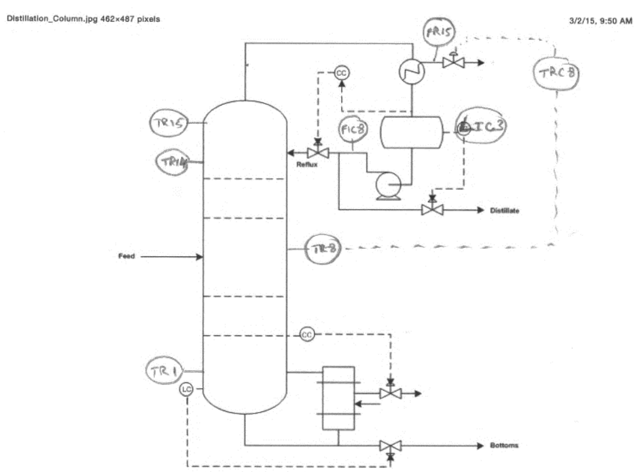
I like to use a methodology called CADET= Critical Action and Decision Evaluation Technique.

This method is based on the Rasmussen step ladder model. The basic units of CADET are the critical actions or decisions (CADs) that need to be made by the operator usually in response to some developing abnormal state of the plant. A CAD is defined in terms of its consequences. If a CAD fails, it will have a significant effect on safety, production or availability.

The following approach is then used to analyze each CAD. The first stage consists of identifying the CADs in the context of significant changes of state in the system being analyzed. The approach differs from the Operator Action Event Trees (OAET) in that it does not confine itself to the required actions in response to critical system states, but is also concerned with the decision making which precedes these actions.

Having identified the CADs that are likely to be associated with the situation being analyzed, each CAD is then considered from the point of view of its constituent decision/action elements. These are derived from the Rasmussen Step Ladder model and reproduced in linear form in the diagram below. The potential failures that can occur at each of these elements are then identified.

To illustrate how CADET can be applied to decision analysis the chart below describes a hypothetical example an experienced worker who should diagnose a plant failure (e.g. top reflux pump failure in a distillation column). A column is created for each decision/action element of the Rasmussen decision ladder to allow an extensive description of how the worker processes diagnostic information and eliminates an initial set of possible equipment failures to arrive at the actual problem. CADET presents the analyst with a structured list of questions about potential diagnostic errors. The protocol in chart shows a good diagnostic strategy in which the worker is looking initially for spurious indications before drawing any conclusions about the state of process equipment. CADET can be used both to evaluate and to support human performance in terms of training exercises.



Time	Signal	Data	Identification	Interpretation	Goal Selection

	detection	Collection			
t1	Column temperature alarm		Not a complete indication.	Cross examine other instruments	
t2		TR014=High TR15=Very High (check)	Inadequate cooling of column or thermal condition of input are distributed	Distinguish between the two. Examine flow rate and temp. input	
t3		F11 Normal FR15 Normal (check) TRC8 Normal	Conditions are as specified. It must be inadequate cooling of column	Possible causes: Cooling water pump failure. Top Reflux Pump failure	
t4		LIC3=High Drum sight glass = High		Level Drum is High thus condensation is OK. It must be failure of the Reflux Pump	
t5		FIC 8 No Flow		Top Reflux Pump failure (confirmed)	Alternative Goals: Reduce Heating in the reboiler. Reduce Flow Rate of input. Increase cooling in condenser.

CADET

TR14, TR15 = Column Temperature

LIC3 = Level in reflux drum

FIC8 = Reflux Flow

F11, FR15 = Crude flow at entry point

TRC8 = Crude temperature at entry point

Decision/Action Element	Objective	Typical Error Pattern
Initial Alert	Alerting/Signal Detection of initial stages of problem	Distraction/ Absent-Mindedness/ Low Alertness
Observation	Observation/ Data Collection from instruments	Unjustified Assumptions/ Familiar Associations/
Identification	Identify System State	Information Overload Time Delay
Interpretation	Interpret what has happened and its implications	Failure to Consider Alternative Causes/ Fixation on the Wrong Cause
Evaluation	Evaluation and Selection of Alternative Goals	Failure to Consider Side Effects/ Focusing on Main Event
Planning	Plan success path	Wrong Task May be Selected due to Shortcuts in Reasoning and Stereotyped Response to Familiar State
Procedure Selection/ Formulation	Choosing or formulating a procedure to achieve required objective	Procedural Steps Omitted/ Reversed (Particularly if 'Isolated')
Execution	Executing chosen procedure	Reversals of Direction or Sign (Up/Down, Left/Right) when carrying out action. Habit Intrusion
Feedback	Observe change of state of system to indicate correct outcome of actions	Feedback ignored or misinterpreted

Decision/ Action Elements of the Rasmussen Model (Embrey, 1986)

The CADET technique can be applied both proactively and retrospectively. In its proactive mode, it can be used to identify potential cognitive errors, which can then be used to help generate failure scenarios arising from mistakes as well as slips. Errors arising from misdiagnosis can be particularly serious, in that they are unlikely to be recovered. They also have the potential to give rise to unplanned operator interventions based on a misunderstanding of the situation. The technique can also be applied retrospectively to identify any cognitive errors implicated in accidents.

It is not just about the screen layout

Some of the requirement to be successful in High Performance is related to the hardware and peoples limitations. These restrictions are common to human beings and are associated with our peripheralvision and a humans ability to perceive change. Ergonomic rules apply to viewing angle, whereimportant information should be placed on the screen to ensure change is easily observed. Hence, the design of the console and number of screens is critical.

Bad practice from the past allowed operators to demand more and more screens even though they could not use them and often they just showed repeat information which is already on display. I observed one operator who was using 24 screens and was trying to build an overview display with his desktop monitors. The ISO 11064 ergonomic guidelines high light that this is a poor practice and having an overview screen that is at a different focal length is easier to observe change and provides a change in focal distance helping the eyes from eye strain.

Without over complicating this topic, High Performance is more than a color change; it involves changes in the number of screens and the viewing angles addressing lighting and glare issues.

Providing displays that present information in a clear and task orientated layout that allows easy reading, good detection of change, easy navigation and grouping of faceplates associated with problem resolution.

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