

# Harmonizing Human-Machine Interfaces: A Standard Reference Guide for HMI Design and Management at NCNR

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# Outline

- Background: What is an HMI?
- HMI's at NIST, who created them.
- The problem?
- Our solution, and its projected implementation.
- Future work



# Design References

## 8. REFERENCES

[1] Opto22, “*Building an HMI that Works: New Best Practices for Operator Interface Design*,”

Available: [https://documents.opto22.com/2061\\_High\\_Performance\\_HMI\\_white\\_paper.pdf](https://documents.opto22.com/2061_High_Performance_HMI_white_paper.pdf)

[2] Whipple, James R. (Fed) & Sahin, Dagistan (Fed). Interview. Conducted by Navid Misaghian. 15 June 2023.

[3] ISA-TR101.02-2019 - HMI Usability and Performance

[4] ANSI/ISA-101.01-2015 - Human Machine Interfaces for Process Automation Systems

[5] ANSI/HFES 100-2007 - Human Factors Engineering of Computer Workstations

[6] NASA Ames Research Center, Color Usage Research Lab - <https://colorusage.arc.nasa.gov/>

Rockwell Automation Process HMI Style Guide White Paper

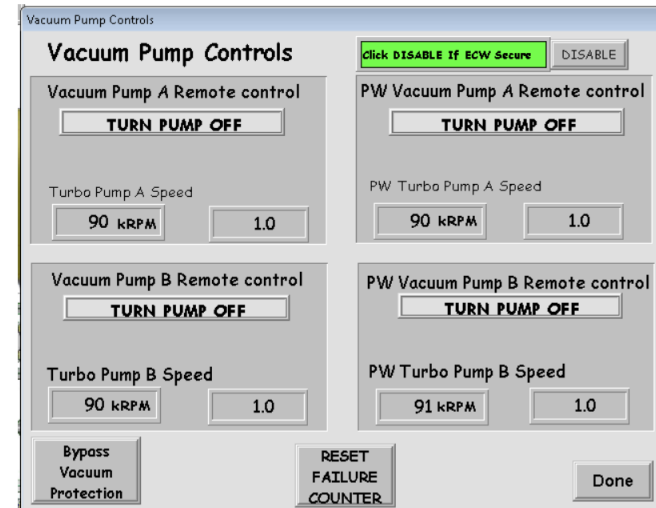
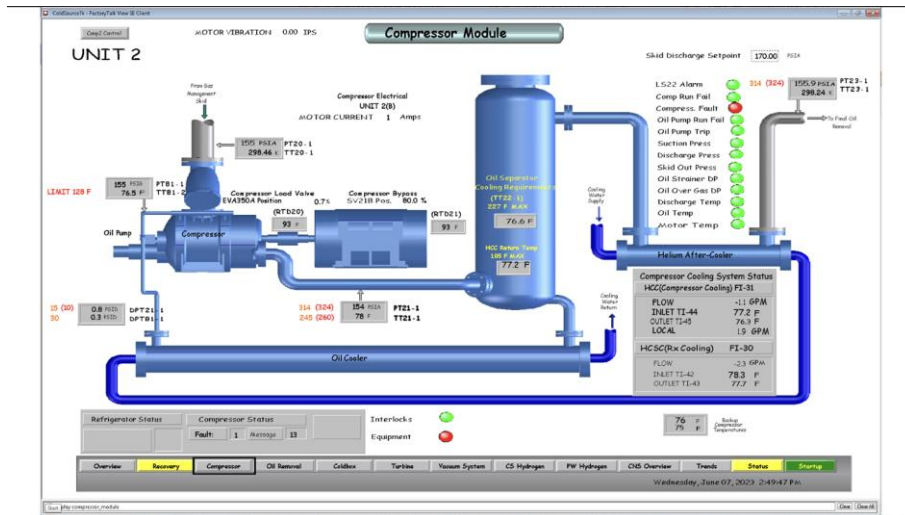
[7] Mica R. Endsley, “Designing for Situation Awareness in Complex Systems,” Proceedings of the second international workshop on symbiosis of humans, artifact, and environment, Kyoto, Japan, 2001. <http://satechnologies.com/Papers/pdf/SA%20design.pdf>

[8] PROCES-RM002 (Rockwell Automation Library of Process Objects: Configuration and Usage)

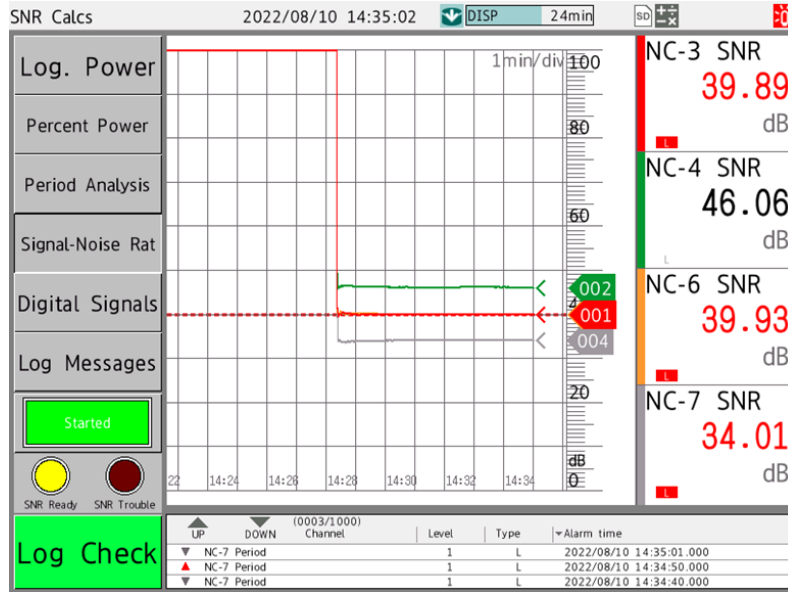
[9] PROCES-RM014 (Rockwell Automation Library of Process Objects: Display Elements)

[10] Usability Body of Knowledge, UXPA, <http://www.usabilitybok.org/task-analysis>

# What is an HMI?



# The current HMI's at NIST, and who created them?

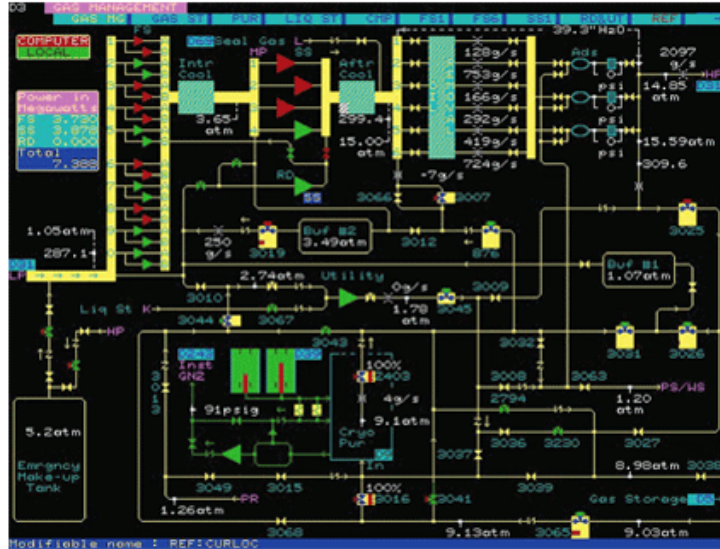
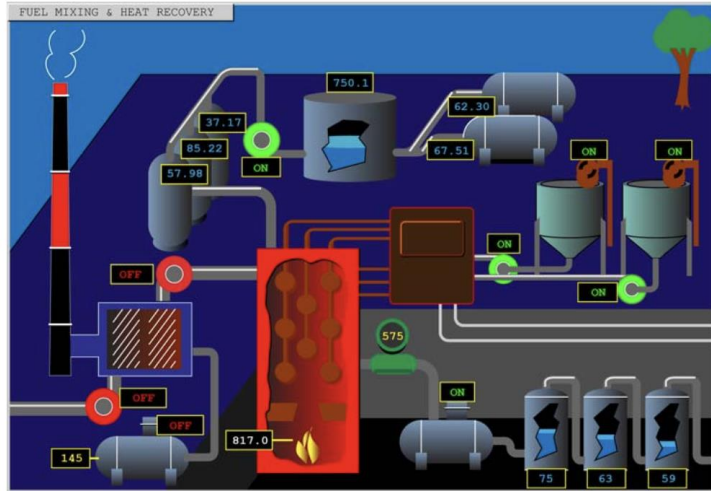


Noise Monitor HMI created by James Whipple



# The problem?

An example of a poor HMI



# Task Analysis

**Task analysis is the process of understanding how a user performs their task and achieves their goals.**

*NUREG-0711 defines a task as a “group of related activities with a common objective.”*



# User Definition

- Understanding End-Users
- Significance of User Experience
- Four Key User Groups
  - Guided by ANSI/ISA 101.01 standard definitions
- Unique Needs of Each Group
- Designer's Role





# Uptime

In the face of increasingly complex machinery, it is crucial to understand that the sophistication of Human-Machine Interfaces (HMIs) does not render them immune to system failures and lockouts.

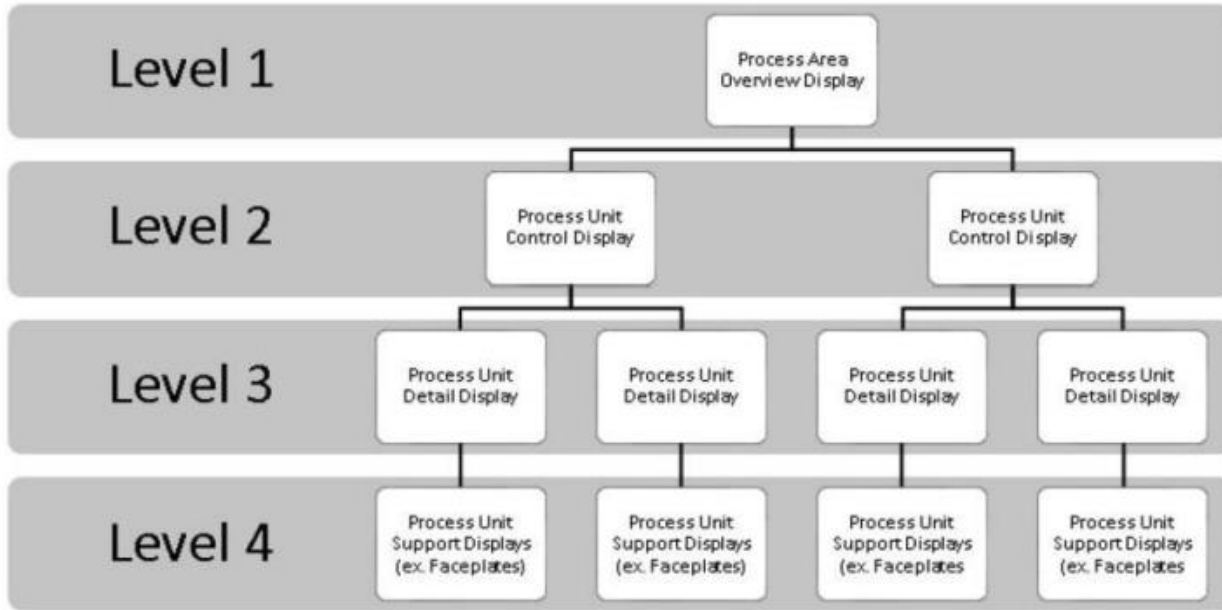


+ HMI

Digital Clocks w/Seconds

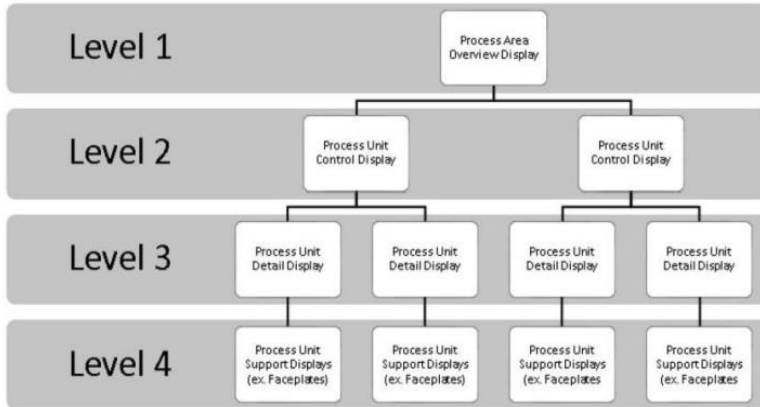


# Level Hierarchy in HMI's

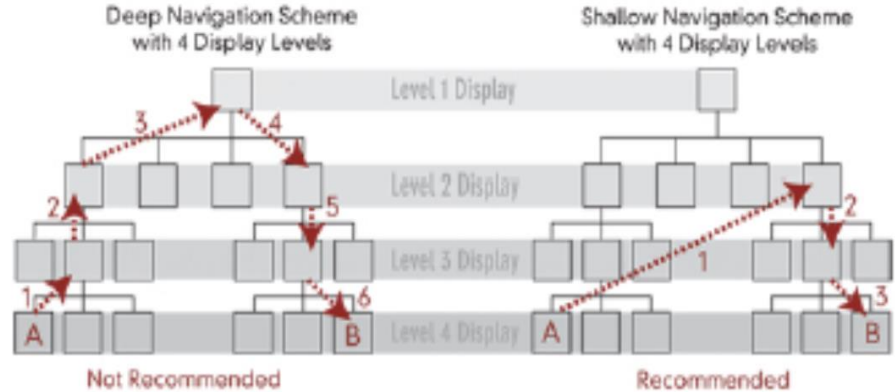


References:  
Rockwell  
Automation Process  
HMI Style Guide

# Navigation



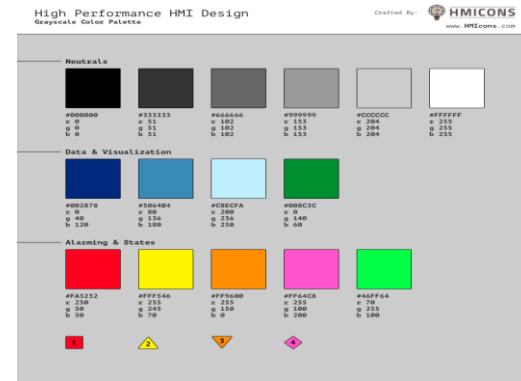
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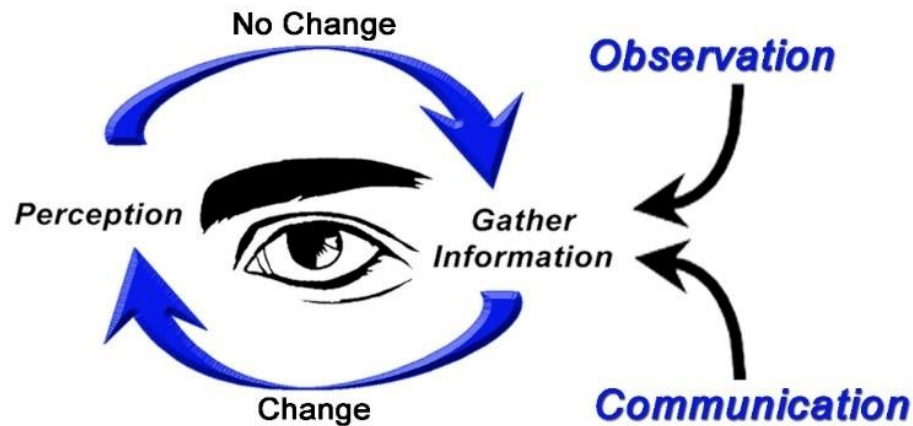
When considering the design of an HMI, navigation plays a pivotal role. Image provided by ASM Consortium.

# Color Hierarchy

Color	UI Element	Meaning
Red	P&ID Device Icons such as pumps and motors	Running
	Alarms	Alarm is active.
Green	P&ID Device Icons such as pumps and motors	Stopped



# Situational Awareness



## Situational Awareness Levels

Comatose – Not able to function

High Alert – Confirmed threat, must act

Focused Awareness – Carefully observing a potential threat

Relaxed Awareness – Enjoying life while paying attention

Tuned Out – Not paying attention

# Conclusions and Future Work

## ABSTRACT

*The National Institute of Standards and Technology's Center for Neutron Research (NCNR) houses a diverse array of complex human-machine interfaces (HMIs), each distinguished by unique color schemes, designs, and structures. This project's primary objective is to develop a comprehensive standard reference guide for future HMI implementations within the NCNR. Well-structured HMIs are instrumental in decreasing training time, curtailling startup or shutdown durations, and minimizing any uncertainties associated with machine interfaces. This initiative aims to bolster consistency, ease of use, and boost operational efficiency across the center's machinery.*

*To streamline this project, we leverage key industry standards from diverse sources, including ISA, ANSI, and HFES. These guidelines shape our approach towards usability and performance, enabling us to tailor our standard guide to meet the varied and diverse needs of the NCNR's user base. This project emphasizes the crucial role of trained human factors engineers in implementing and assessing these specifications.*

*By assessing insights from these references with existing practices at NCNR, our aim is to create a reference guide encapsulating the best principles of HMI design and management. Ultimately, this project will enhance machine interactions at NCNR, establishing a foundation for improved user experiences, a unified design aesthetic, and streamlined operations.*

## 1. DEFINITIONS

<i>GUI</i>	<i>Graphical User Interface</i>
<i>HEP</i>	<i>Human Error Probability</i>
<i>HFE</i>	<i>Human Factors and Ergonomics</i>
<i>HMI</i>	<i>Human-Machine Interface</i>
<i>HPA</i>	<i>Human Performance Analysis</i>
<i>HRA</i>	<i>Human Reliability Analysis</i>
<i>NBSR</i>	<i>National Bureau of Standards (now known as NIST) Reactor</i>
<i>NCNR</i>	<i>NIST Center for Neutron Research</i>
<i>NIST</i>	<i>National Institute of Standards and Technology</i>
<i>PLC</i>	<i>Programmable Logic Controllers</i>
<i>PSF</i>	<i>Performance-Shaping Factor</i>
<i>SA</i>	<i>Situational Awareness</i>
<i>User</i>	<i>Any individual who operates or controls an HMI as part of their duties assigned in the NCNR.</i>

## 2. INTRODUCTION

### 2.1. What is an HMI?

An HMI, or Human-Machine Interface, is more than just a user interface; it's a crucial platform designed specifically to enable users to observe, control, and troubleshoot mechanical systems and apparatuses. Although it is feasible to apply this definition to any interactive screen engaging with a device, the usage of HMI is predominantly confined within industrial contexts.

HMI and Graphical User Interfaces (GUI) bear some semblance in functionality; however, they are not interchangeable concepts. Often, GUIs are utilized within HMIs to augment the visual interpretation of information.



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