NEXT-GENERATION SCADA HIGH PERFORMANCE HUMAN MACHINE INTERFACES

Configuring HMIs to Display “Operator-centric” Information

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Learning Objectives

- Recognize key components of a plant or facility Human Machine Interface (HMI)
- Define *situational awareness* as it relates to SCADA systems and identify common HMI pitfalls working against it
- Describe how High Performance HMI (HPHMI) concepts serve to enhance situational awareness
- Review several examples of HPHMI in practice
Presenting Objectives
Introduction

Automation and SCADA systems are fundamental to water resource plant operations

Operators struggle with massive amounts of alarms, increasing screen counts and I/O

Information is presented in ways that may not enhance situational awareness
1. BACKGROUND OF HMI ENGINEERING
SCADA Components

Enterprise Systems

Remote Site Telemetry

HMI/OIT

Controllers

Packaged Vendor Systems

VFDs/Actuators

Field Instruments

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HMI - Human Machine Interface – The collection of displays (hardware and software) that allows an operator to “see and hear” the process
History of HMI: 90s/00s

Computerized SCADA systems

Control engineer prepares Process and Instrumentation Diagrams (P&IDs)

HMI software provides toolkits, features, objects, colors

Contractor/System Integrator configures HMI based on P&IDs and specifications
Typical Current HMI Screens
2. SITUATIONAL AWARENESS
Situational Awareness (SA)

Situational awareness (SA) is the **perception** of environmental elements with respect to time or space, the **comprehension** of their meaning, and the **projection** of their status after some variable has changed, such as time or an event.
Situational Awareness (SA)

“The relationship between the operator's understanding of the plant's condition and its actual condition at any given time”

- International Society of Automation (ISA)
HMI Impacts to SA

Performance shaping factors:

“Attention tunneling” Misplaced emphasis
Reliance on Short-term Increasing Complexity
 Memory Improper Mental Model
Physical and mental stress Automation, loss of institutional knowledge (“out-of-the-loop”) syndrome
Too much data

“Too much data” “Increasing Complexity”

Too many alarms
Too many options
Easy to configure
Built-in alarms for analog
Custom graphics development

Configured Alarms per Operator

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“Misplaced Emphasis” “Too much data”

Where is the alarm?

ALM: 02_UA1002 DWP#304 PMPBR FAILTRP#12
3. “HIGH PERFORMANCE” HMI
High Performance HMI

ISA Standard 101 Terms:
• “High Performance”
• “High Impact”
• “Next Generation”
• “Situational Awareness”

HPHMI - Providing an interface to the process that is operator-centric, and focuses on human factors, the operator’s mental model, and enhancing the operator’s situational awareness.
Visual

Display

- Contrast
- Repetition
- Alignment
- Proximity

Graphic Development

- Use of Color and Shape
- Use of Patterns
- Use of Trends

Source: Stock Photo
Use of Color and Shape

Use color and shape to focus attention

- Muted Background (Gray)
- Avoid Run/ Stop/ Open/Close Color, use contrast instead
- Indicate alarms with both color and shape

Source: The High Performance HMI Handbook (Hollifield et al., 2008).
Use of Patterns and Analog Indicators

- “At-a-Glance”
- Analog Indicator
- Pattern Recognition Objects (PROs)
  - Profile Displays
  - Radar Plots

Source: The High Performance HMI Handbook (Hollifield et al., 2008).
Use of Trends

- Enhanced use of trends
- Embedded “road-map” trending

Features:
- Alarm and shutdown levels
- Setpoints
- Time interval

Tank 1
Level: 20.2 ft
2 hr
HMI vs High Performance HMI

Source: HMI Handbook
ISA Standard 101 – HMI Lifecycle Model


- Builds on and brings together threads from various sources (industry / academic partners)
- Establishes consistent approach to HMI development (process industries)

<table>
<thead>
<tr>
<th>Reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>API 1165</td>
<td>Recommended Practice for Pipeline SCADA Displays</td>
</tr>
<tr>
<td>ASM Consortium Guidelines Rev 3-2008</td>
<td>Effective Operator Display Design</td>
</tr>
<tr>
<td>ANSI/HFES 100-2007</td>
<td>Human Factors Engineering of Computer Workstations</td>
</tr>
<tr>
<td>ANSI/HFES 200-2008</td>
<td>Human Factors Engineering of Software User Interfaces</td>
</tr>
<tr>
<td>ISO 9241</td>
<td>Ergonomic requirements for office work with display terminals</td>
</tr>
<tr>
<td>ISO 11064</td>
<td>Ergonomic design of control centers</td>
</tr>
<tr>
<td>EEMUA 201</td>
<td>Process plant control desks utilizing human-computer interfaces: a guide to design and human-computer interfaces</td>
</tr>
<tr>
<td>NUREG-0700 Rev. 2-2002</td>
<td>Human-System Interface Design Review Guidelines</td>
</tr>
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Tiers of HPHMI

Philosophy

Navigation

Style Guide

Tier 1 - Overview

Tier 2 – Unit Process

Tier 3 – Unit Detail

Tier 4 – Diagnostic
4. EXAMPLES OF HPHMI IMPLEMENTATION
Pattern Recognition Objects (PRO) in Practice

<table>
<thead>
<tr>
<th>Parameter</th>
<th>iFix HMI Range</th>
<th>“Good” Process Range</th>
<th>(FOR HMI CONFIG ONLY) Normalized PRO Object Limits (Horizontal Pos.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>NITRATE (Pass 1-1/Pass 4-2)</td>
<td>0-20 ppm</td>
<td>0.5 ppm</td>
<td>3 ppm</td>
</tr>
<tr>
<td>NITRATE (Pass 4-5)</td>
<td>0-20 ppm</td>
<td>2 ppm</td>
<td>6 ppm</td>
</tr>
<tr>
<td>DO (all locations)</td>
<td>0-5 ppm</td>
<td>1 ppm</td>
<td>2.5 ppm</td>
</tr>
<tr>
<td>ORP (anoxic)</td>
<td>-2000-+2000mV</td>
<td>-80 mV</td>
<td>+20 mV</td>
</tr>
<tr>
<td>Ammonia (Pass 4)</td>
<td>0 – 50 ppm</td>
<td>2 ppm</td>
<td>5 ppm</td>
</tr>
</tbody>
</table>

Low alarm condition

Normal Process Range

Outside normal process range, yellow indicates alarm condition

Use red for nitrate/ammonia as higher priority alarm than DO

No numbers/values needed on overview screen
Example – Tier 1 – Plant Overview

Is the plant doing OK?
Example – Tier 1 – Plant Overview

Is the plant doing OK?
Example – Tier 2 – Unit Process

BNR Unit Process

Nutrient Removal Process

Multiple Analytical Values to review/ check

Is BNR within range?
Example – Tier 2 – Unit Process

Entire Secondary Profile Displays

- DO, Nitrate, Nox
- RAS, etc.

Is BNR within range?
Example – Tier 3

Equipment monitoring

Blower Information:

• Scroll through many screens
• No summary, at-a-glance
• Alarming issues
• Too much information
• Too little information

Is the 1,000 HP Aeration Blower running OK?
Example – Tier 3

Develop Tier I Screen

Multivariable

At-a-glance, normalize parameters in PRO:

• Capacity
• Temperatures
• Vibrations
• Deviation from SP

From 6 screens with 80+ numbers to…1 screen

Is the 1,000 HP Aeration Blower running OK?
Revisit Learning Objectives

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Q&A
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