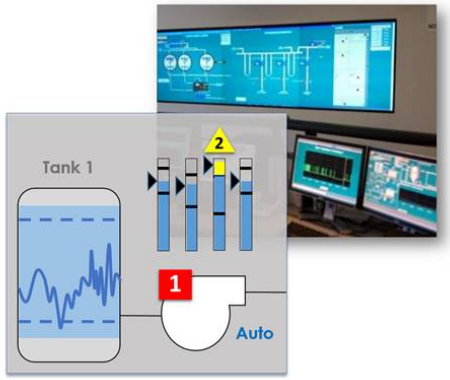

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NEXT-GENERATION SCADA HIGH PERFORMANCE HUMAN MACHINE INTERFACES

Configuring HMIs to Display “Operator-centric” Information

Ryan Kowalski, PE; Ed Kowalski, PE

26 December 2018

Today's Presenter

Tom Armstrong, PE

Background: Electrical and I&C Engineer

Role: Resource Manager in Water Business

One Seagate, Suite 700, Toledo OH 43604

tom.armstrong@arcadis.com

419.213.1602

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

Optimum

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

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Enterprise Systems

Remote Site Telemetry

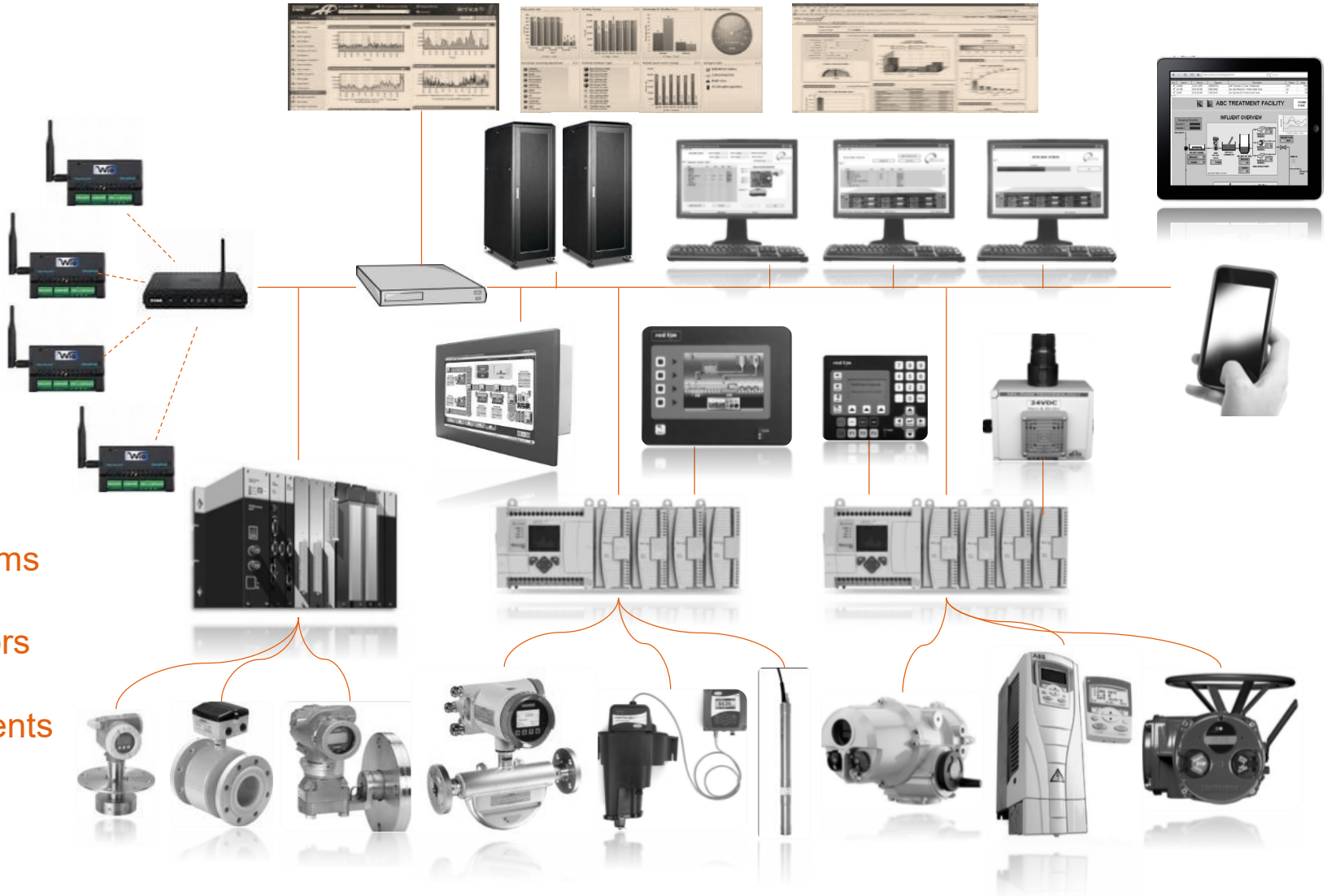
HMI/OIT

Controllers

Packaged Vendor Systems

VFDs/Actuators

Field Instruments



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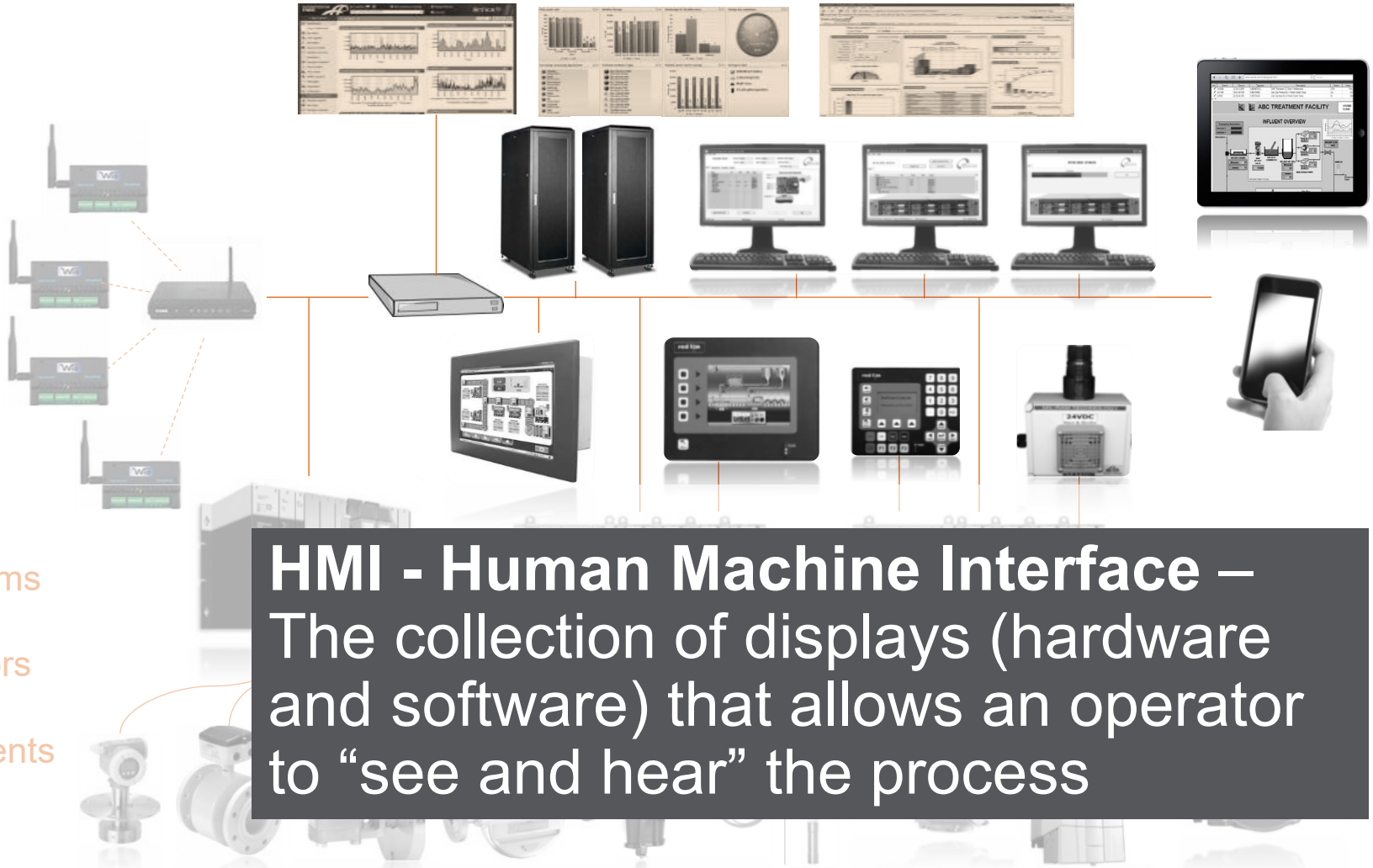


HMI - Human Machine Interface – The collection of displays (hardware and software) that allows an operator to “see and hear” the process

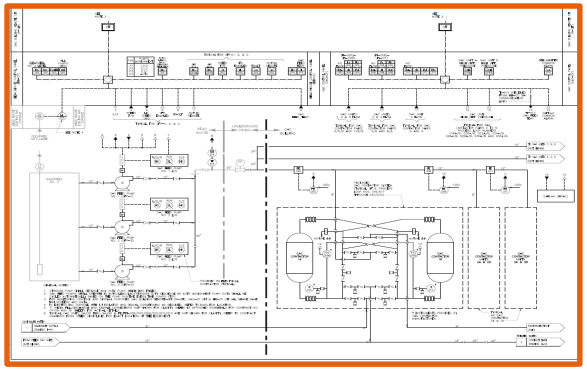
History of HMIs: 90s/00s

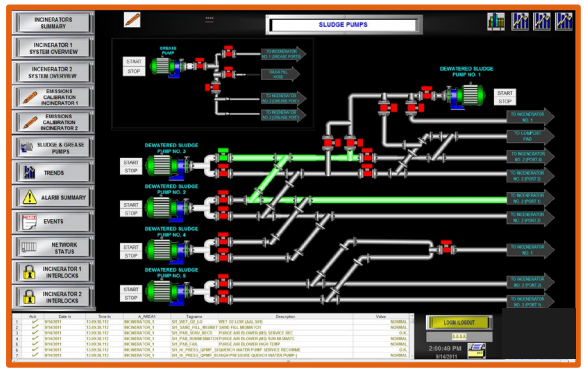
Computerized SCADA systems

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

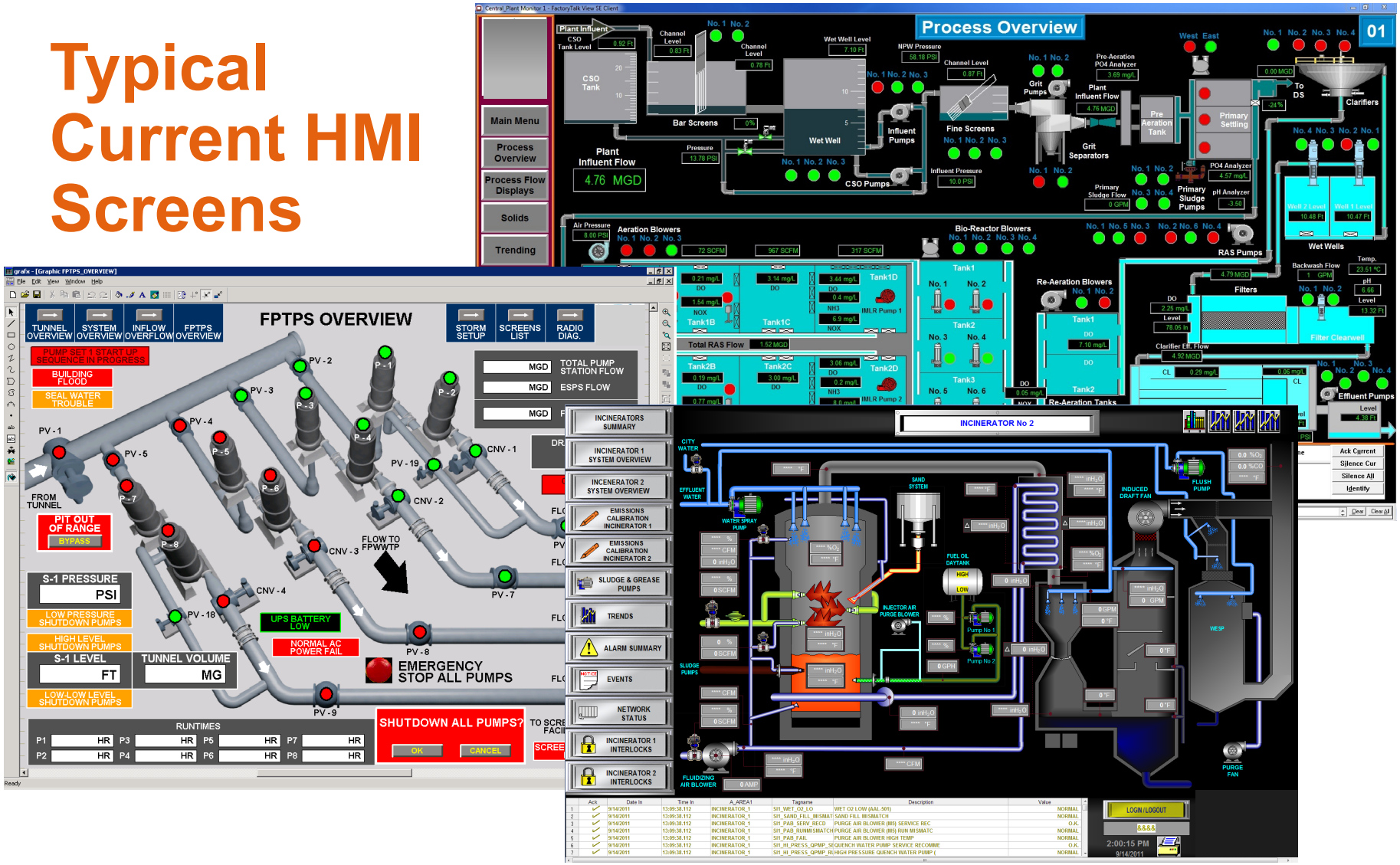
HMI software provides toolkits, features, objects, colors

Contractor/System Integrator configures HMI based on P&IDs and specifications





Typical Current HMI Screens



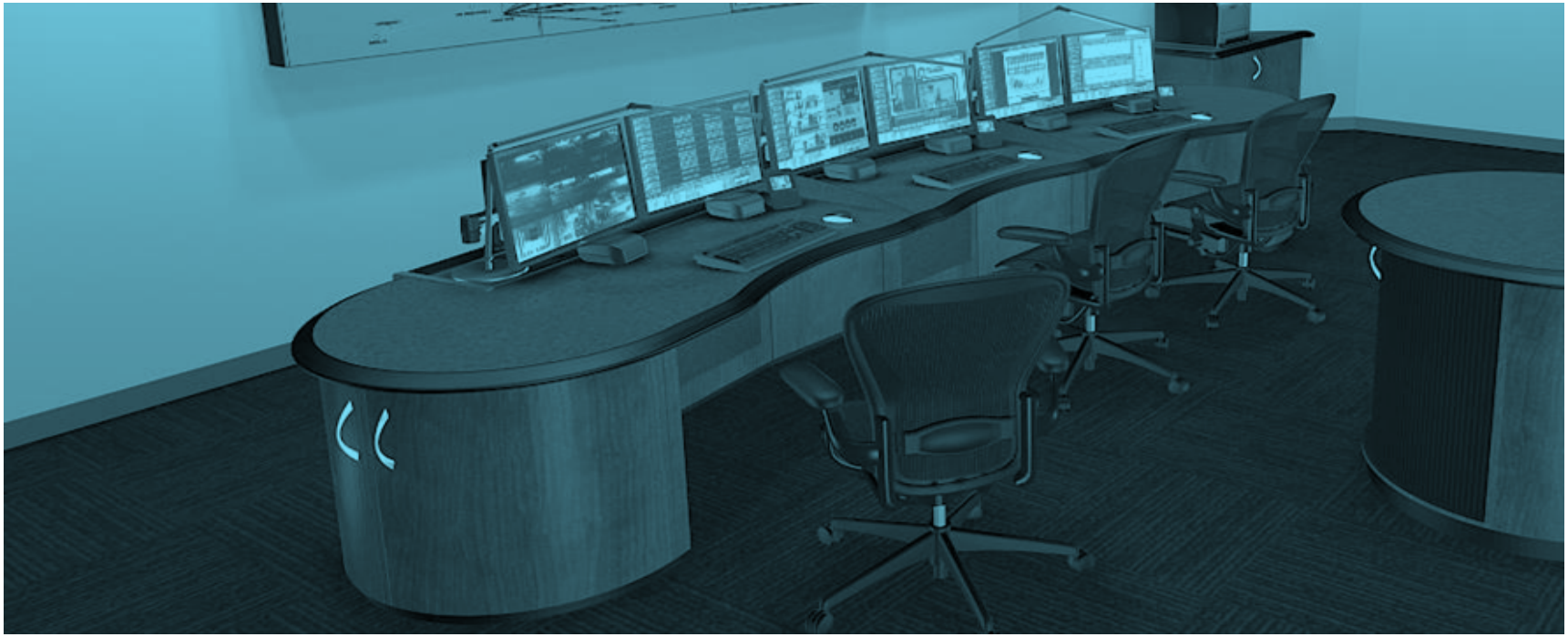
2. SITUATIONAL AWARENESS

Situational Awareness (SA)

Boeing 777 Cockpit

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

Source: Designing for Situational Awareness: An Approach to User-Centered Design, 2nd Edition, Endlsey

“Too much data” “Increasing Complexity”

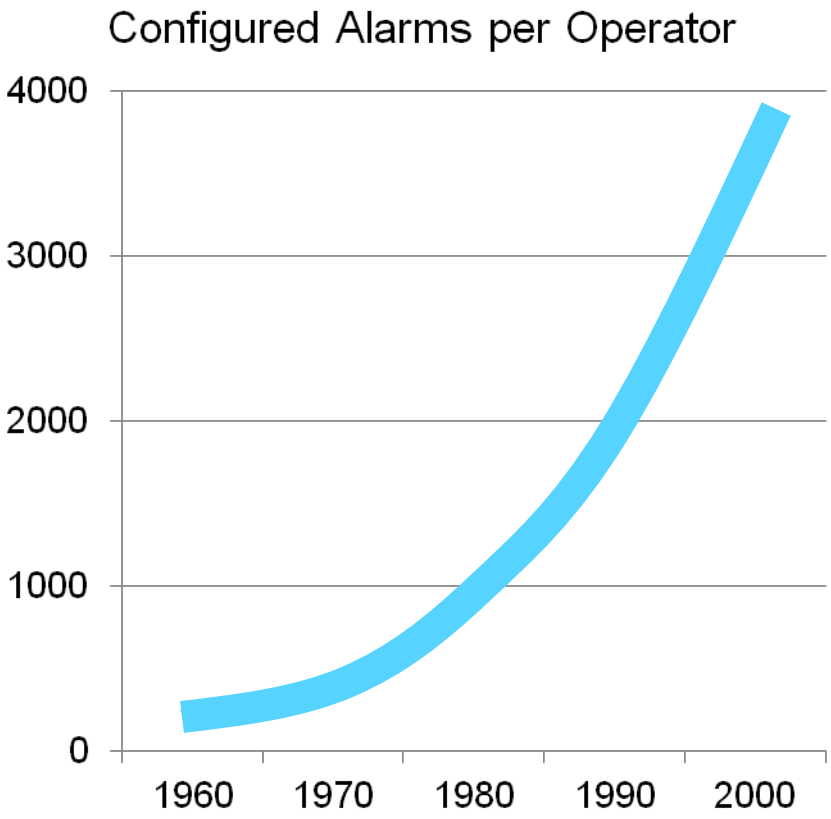
Too many alarms

Too many options

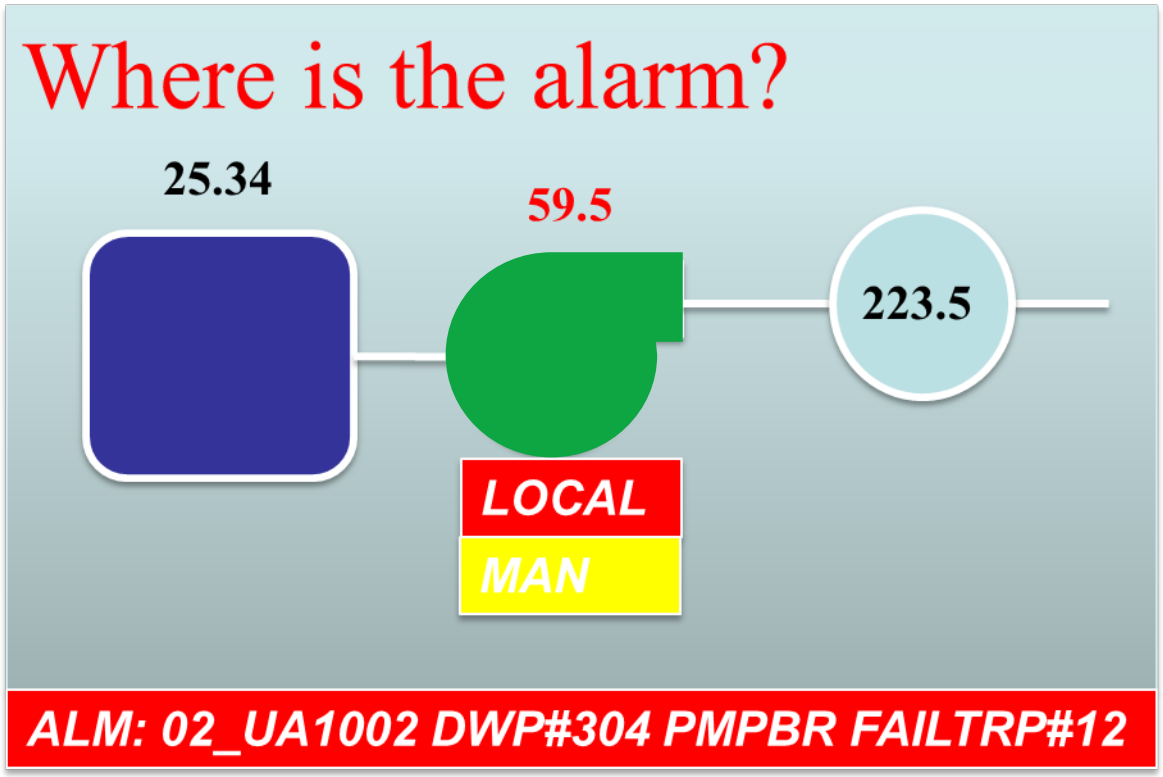
Easy to configure

Built-in alarms for analog

Custom graphics development



“Misplaced Emphasis” “Too much data”



3. “HIGH PERFORMANCE” HMI

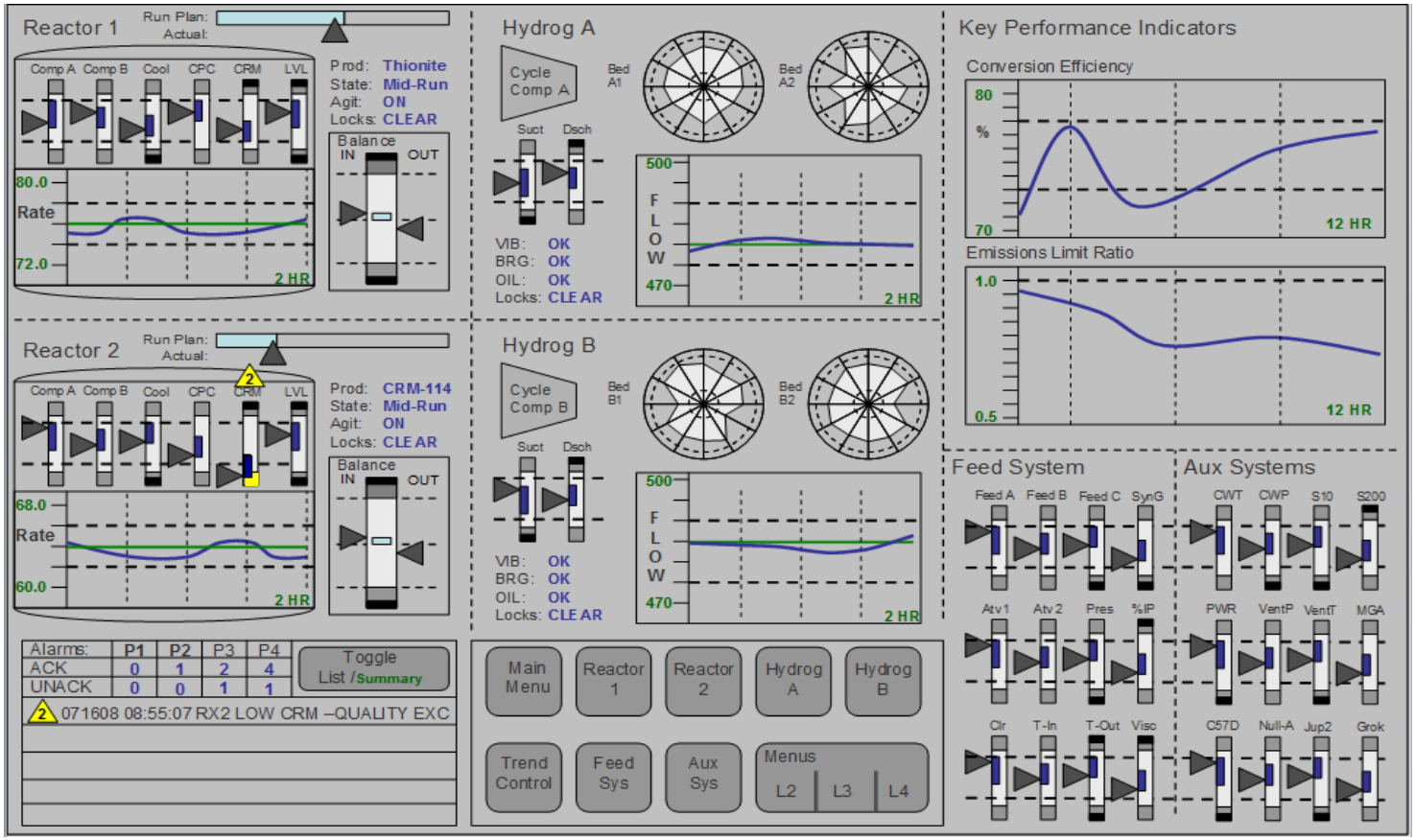
High Performance HMI

ISA Standard 101 Terms:

- "High Performance"
- "High Impact"
- "Next Generation"
- "Situational Awareness"

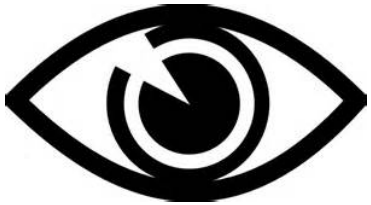
HPHMI - *Providing an interface to the process that is operator-centric, and focuses on human factors, the operator's mental model, and enhancing the operator's situational awareness.*

Visual



Source: HMI Handbook

Visual



Display

- Contrast
- Repetition
- Alignment
- Proximity

Graphic Development

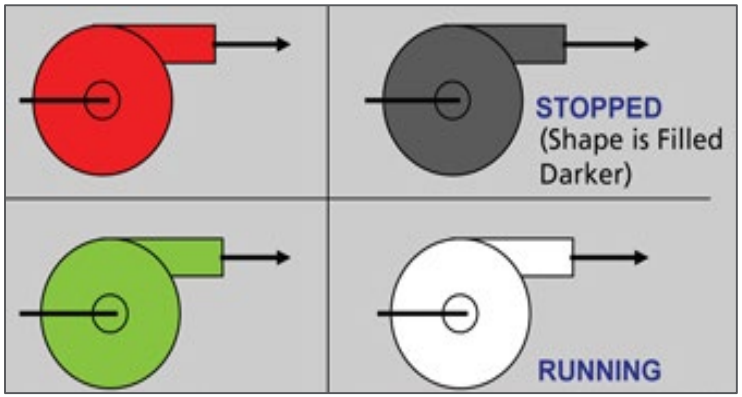
- **Use of Color and Shape**
- **Use of Patterns**
- **Use of Trends**

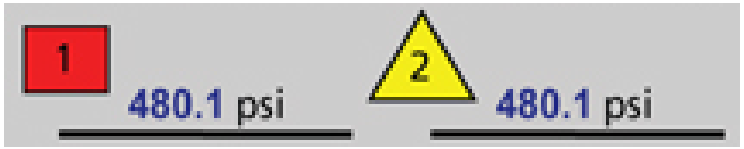
Source: Stock Photo

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

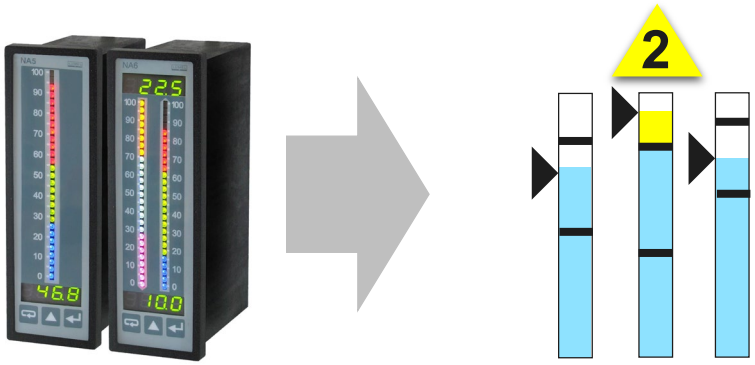


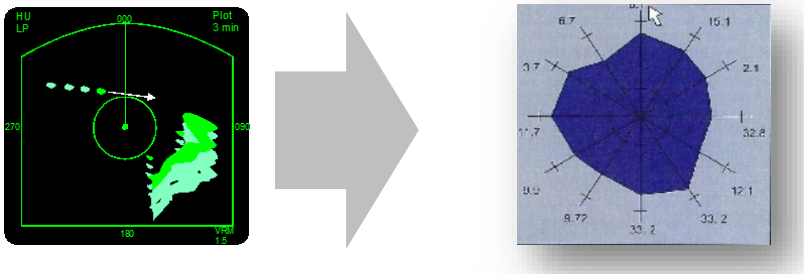


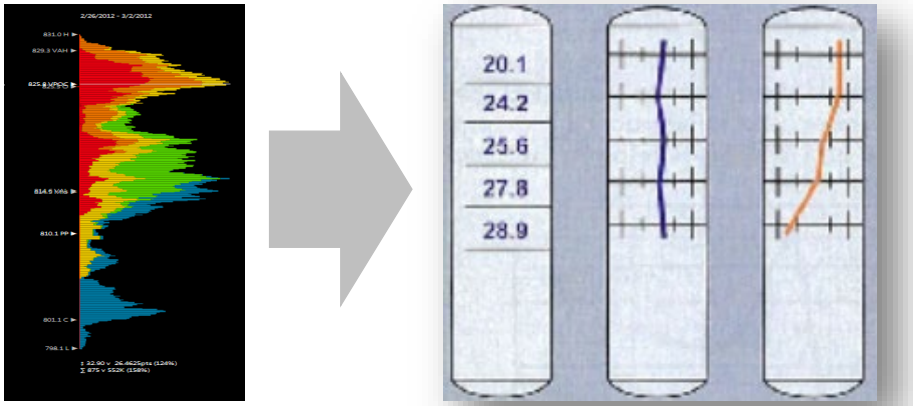
Source: The High Performance HMI Handbook (Hollifield et al., 2008].

Use of Patterns and Analog Indicators

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



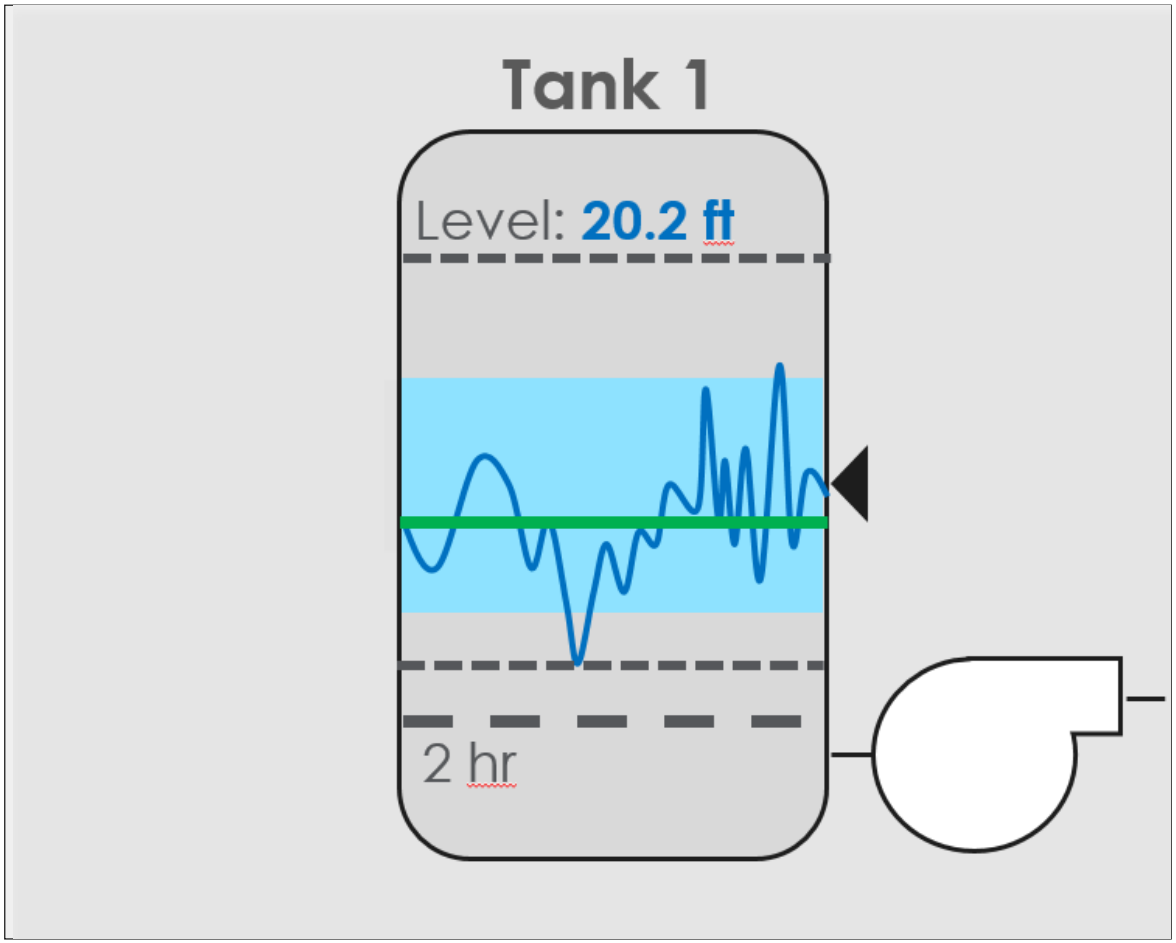




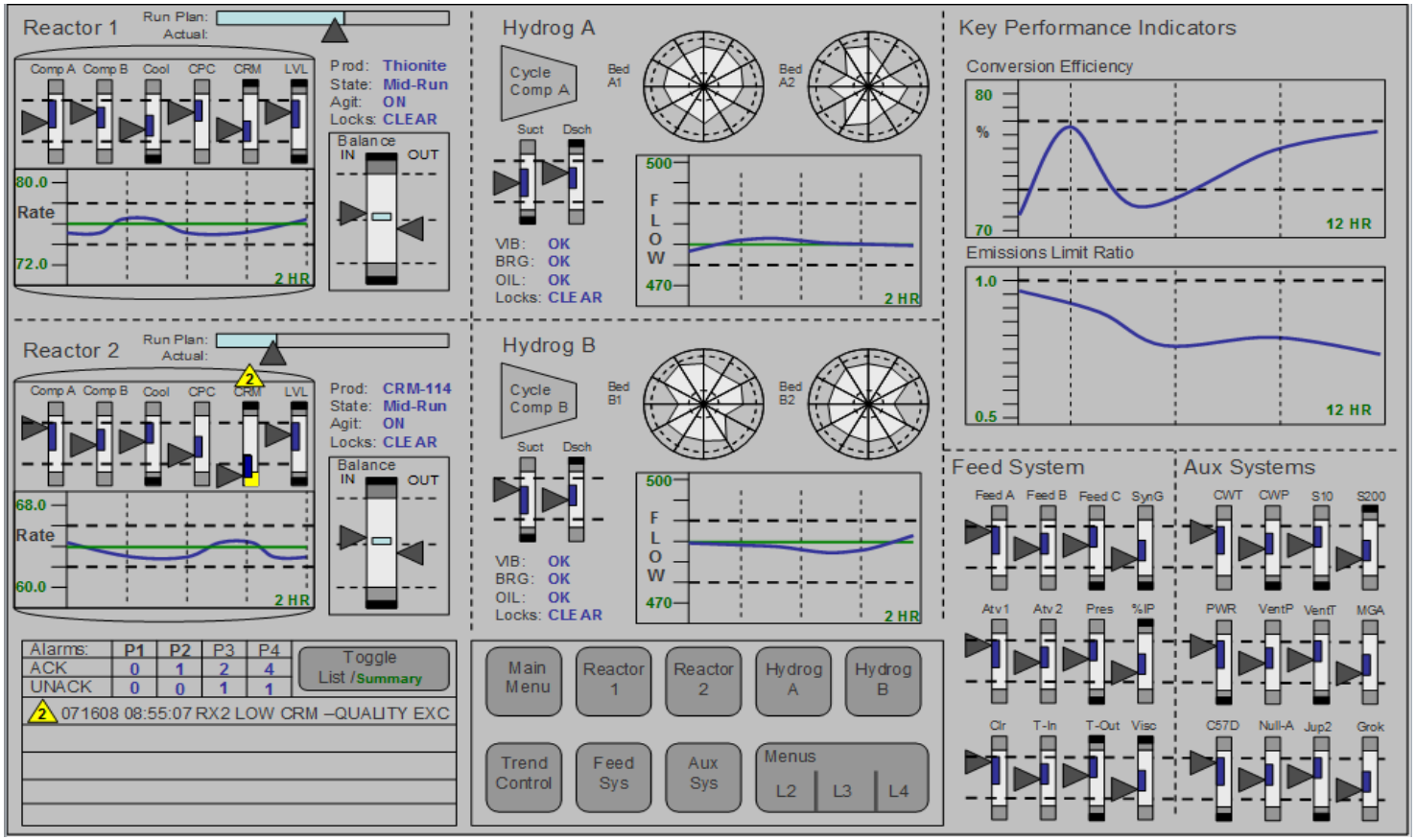
Source: The High Performance HMI Handbook (Hollifield et al., 2008].

Use of Trends

- Enhanced use of trends
- Embedded “road-map” trending
- Features:
  - Alarm and shutdown levels
  - Setpoints
  - Time interval



HMI vs High Performance HMI



Source: HMI Handbook

ISA Standard 101 – HMI Lifecycle Model

ANSI/ISA 101 (2015) Human Machine Interfaces for Process Automation Systems

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

API 1165 *Recommended Practice for Pipeline SCADA Displays*

ASM Consortium Guidelines Rev 3-2008 *Effective Operator Display Design*

ANSI/HFES 100-2007 *Human Factors Engineering of Computer Workstations*

ANSI/HFES 200-2008 *Human Factors Engineering of Software User Interfaces*

ISO 9241 *Ergonomic requirements for office work with display terminals*

ISO 11064 *Ergonomic design of control centers*

EEMUA 201 *Process plant control desks utilizing human-computer interfaces: a guide to design and human-computer interfaces*

NUREG-0700 Rev. 2-2002 *Human-System Interface Design Review Guidelines*

Tiers of HPHMI

Philosophy

Navigation

Style Guide

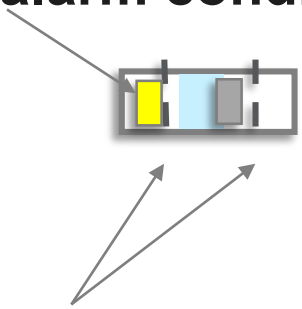
- Tier 1 - Overview
- Tier 2 – Unit Process
- Tier 3 – Unit Detail
- Tier 4 – Diagnostic

4. EXAMPLES OF HPHMI IMPLEMENTATION

Pattern Recognition Objects (PRO) in Practice

Parameter	iFix HMI Range	"Good" Process Range		(FOR HMI CONFIG ONLY) Normalized PRO Object Limits (Horizontal Pos.)	
		Lower	Upper	Lower	Upper
NITRATE (Pass 1-1/ Pass 4-2)	0-20 ppm	0.5 ppm	3 ppm	-0.75	4.25
NITRATE (Pass 4-5)	0-20 ppm	2 ppm	6 ppm	0	8
DO (all locations)	0-5 ppm	1 ppm	2.5 ppm	0.25	3.25
ORP (anoxic)	-2000-+2000mV	-80 mV	+20 mV	-100	100
Ammonia (Pass 4)	0 – 50 ppm	2 ppm	5 ppm	0.5	6.5

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

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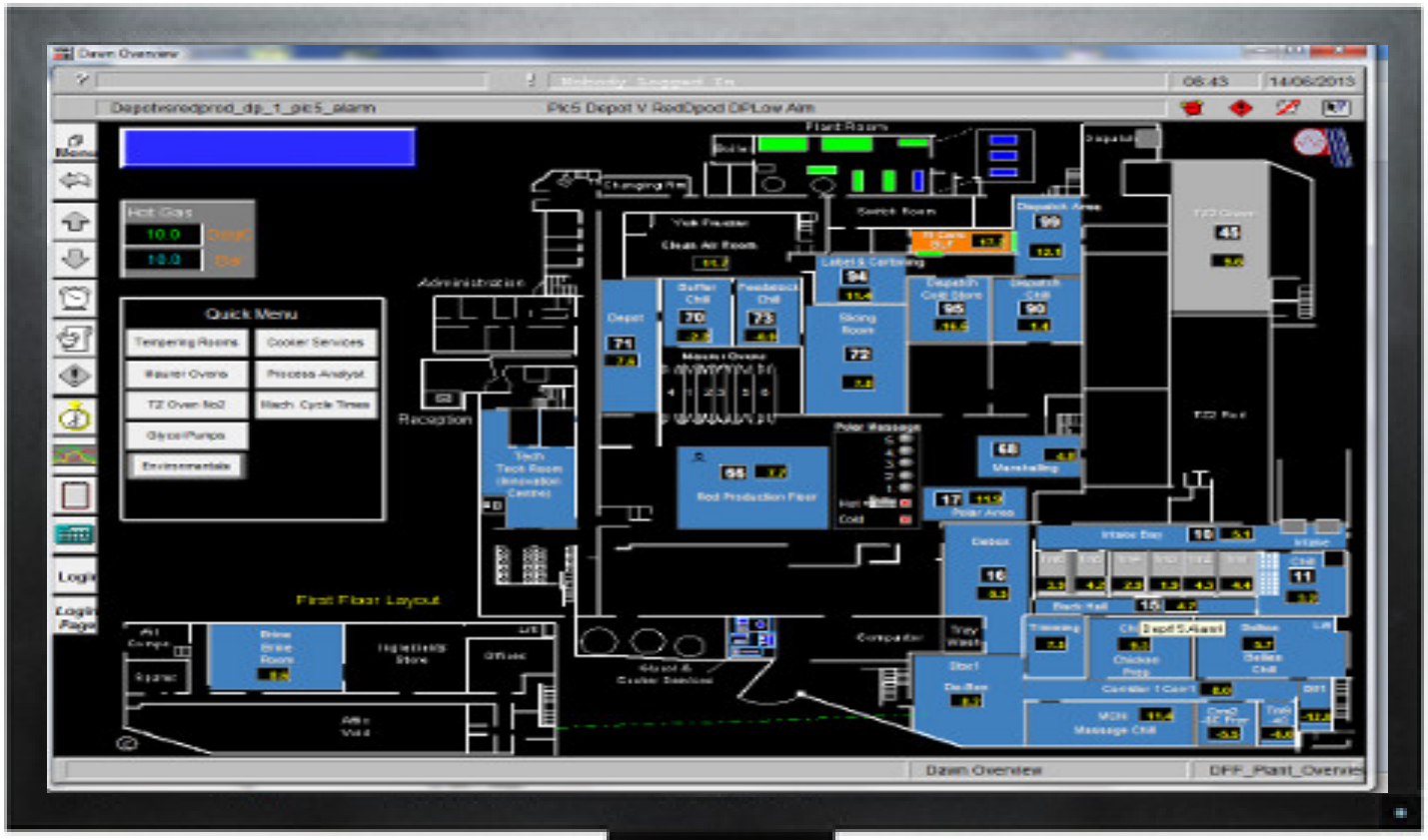
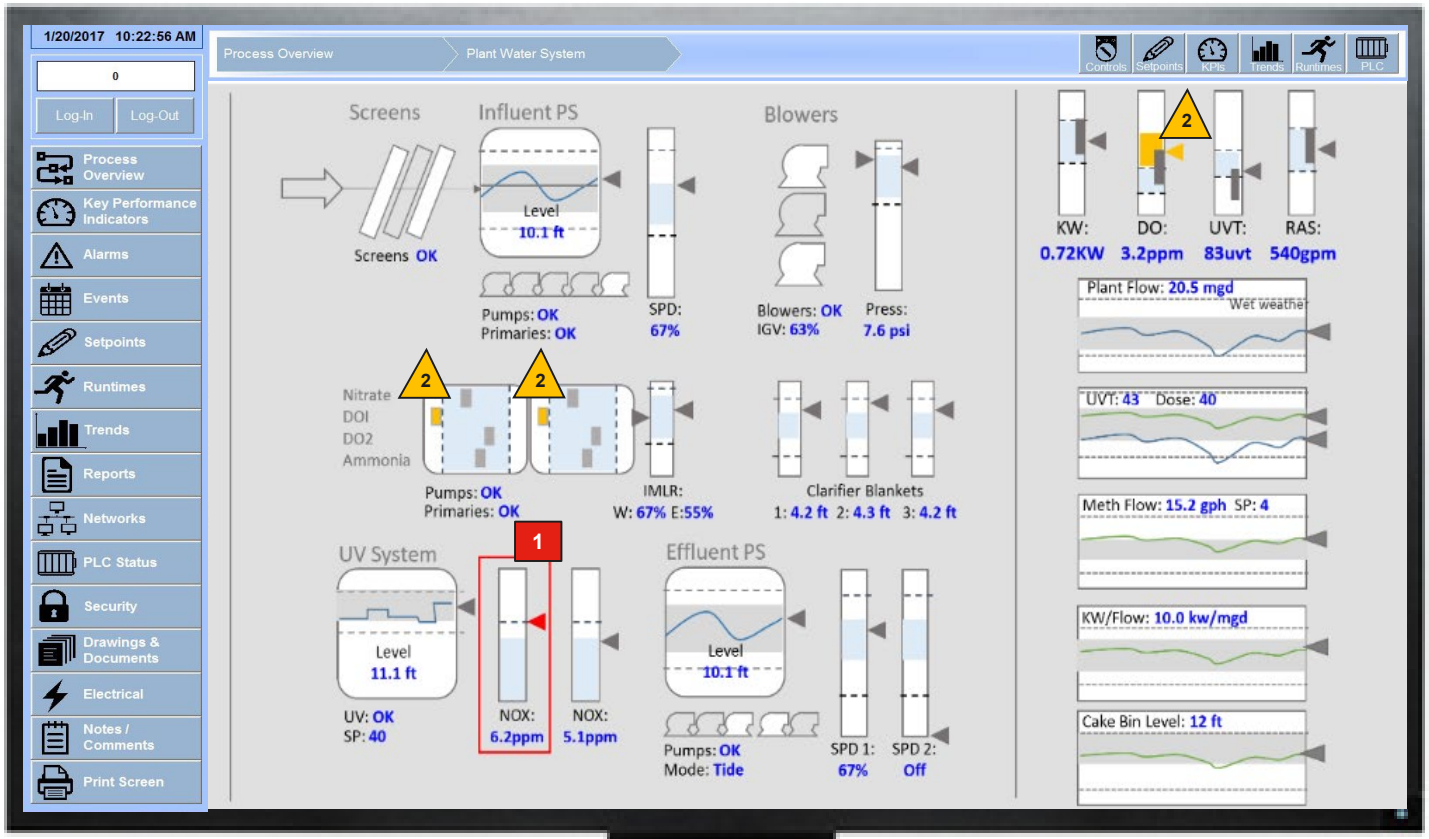
Example – Tier 1 – Plant Overview



Is the plant doing OK?

Example – Tier 1 – Plant Overview



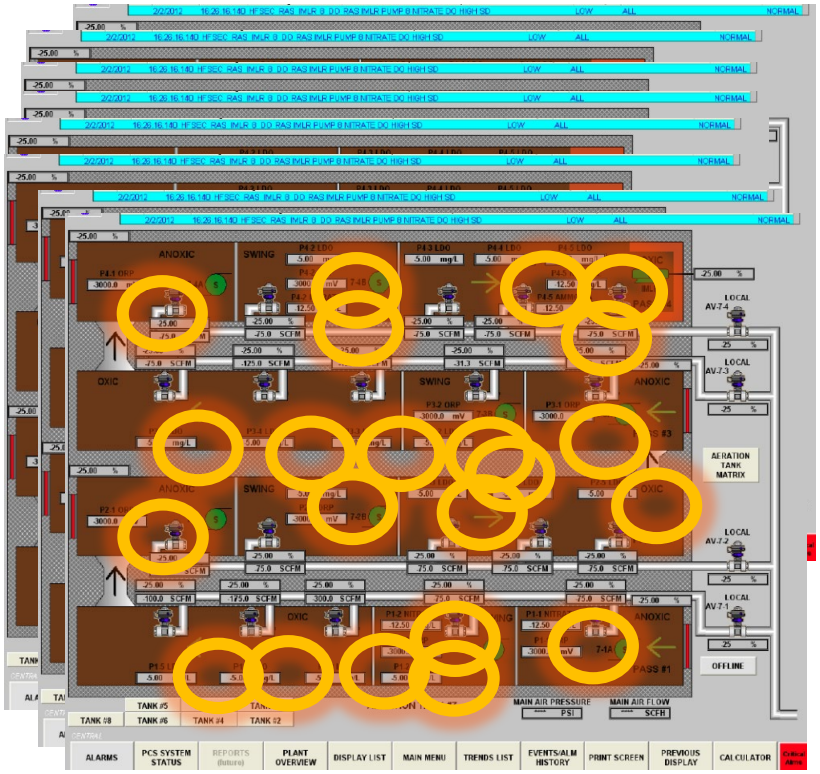
Is the plant doing OK?

Example – Tier 2 – Unit Process

BNR Unit Process

Nutrient Removal Process

Multiple Analytical Values to review/ check



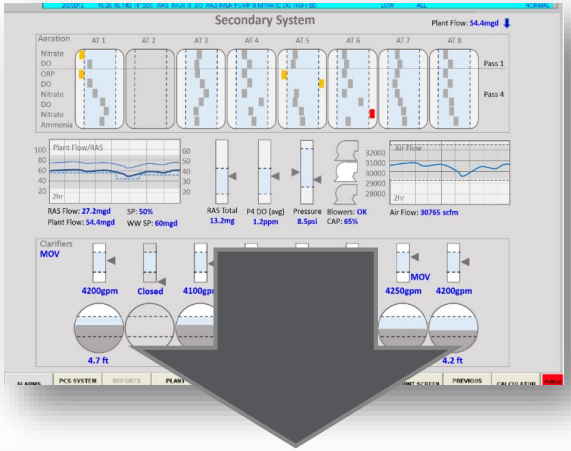
Is BNR within range?

Example – Tier 2 – Unit Process

Entire Secondary

Profile Displays

- DO, Nitrate, Nox
- RAS, etc.



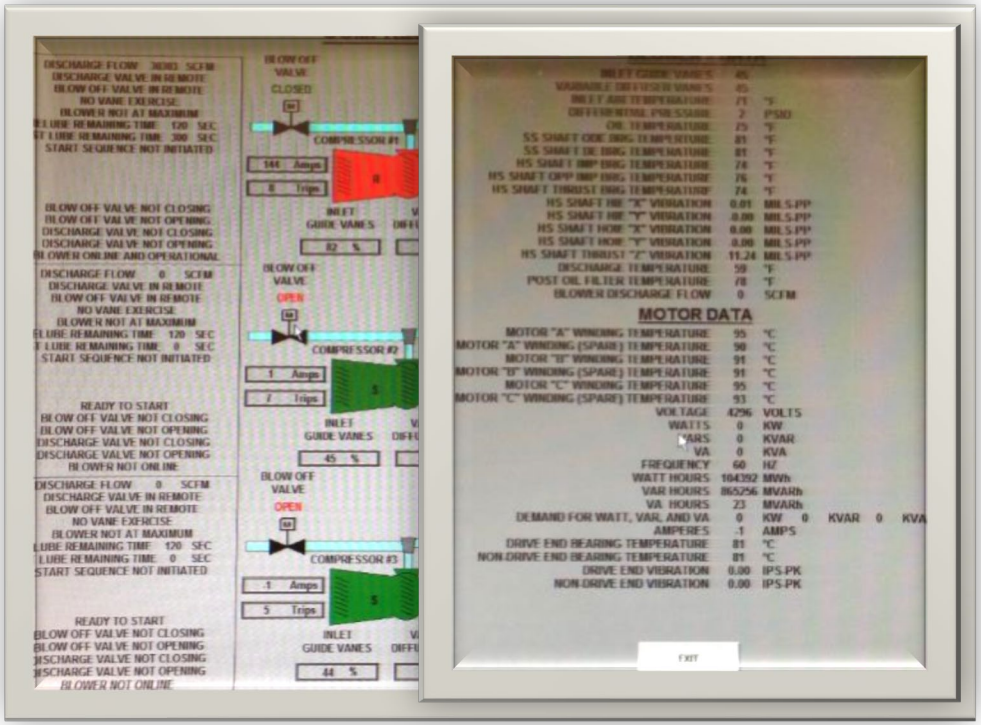
Is BNR within range?

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

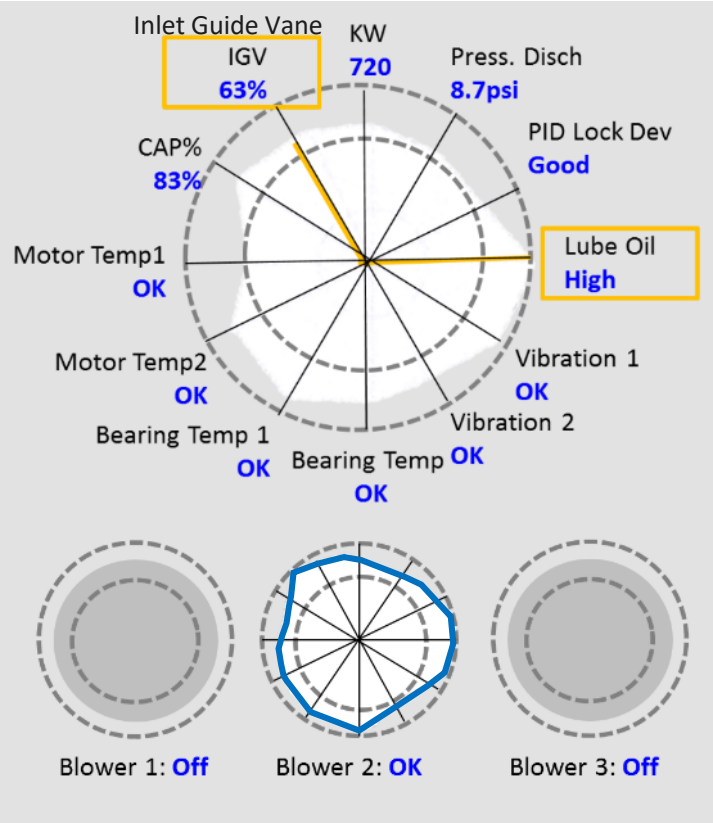
Develop Tier I Screen

Multivariable

At-a-glance, normalize parameters in PRO:

- Capacity
- Temperatures
- Vibrations
- Deviation from SP

From 6 screens with 80+ numbers to….1 screen



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Revisit Learning Objectives

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Q&A

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