ARCADIS Design & Consultancy for natural and built assets

SUCCESSFUL PARTNERING PRODUCES STATE-OF-THE ART SCADA

Edward Abel, SWPCA; Dan Capano, SWPCA; Ed Kowalski, Arcadis, PE, PMP

January 24th, 2017

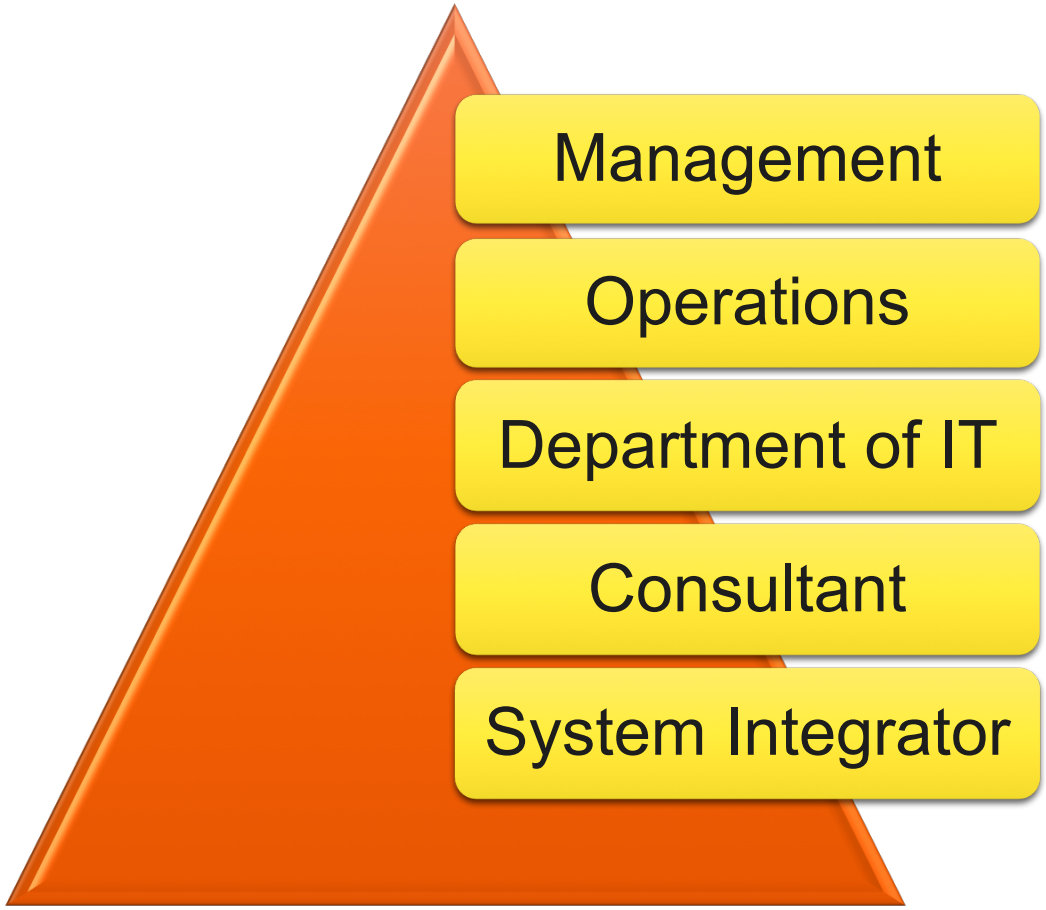
SWCPA (Stamford Water Pollution Control Authority) WWTP, Stamford, CT

24 MGD Wastewater Plant, BNR & UV treatment, 23 remote Pump Stations, legacy Honeywell PlantScape SCADA system

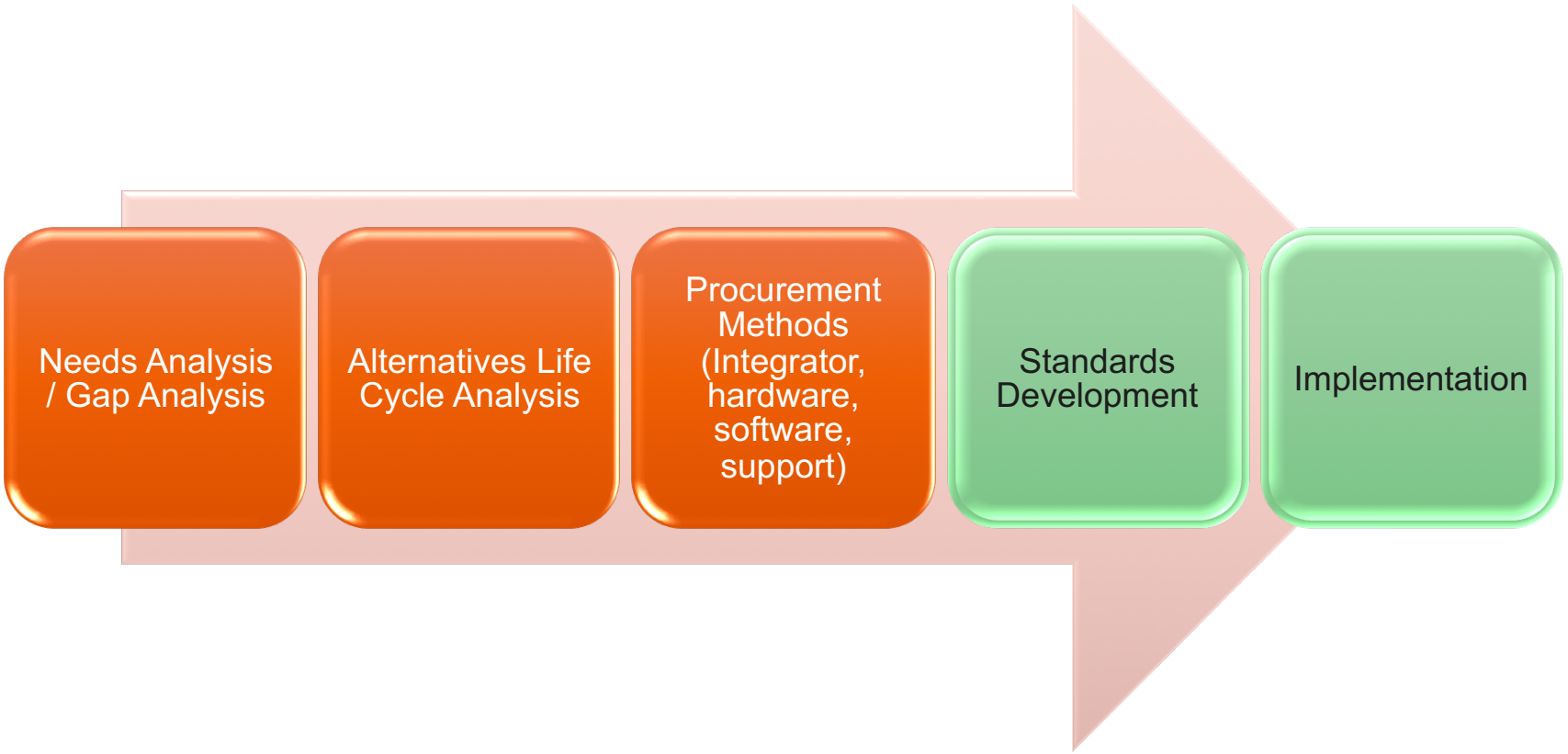
Project Goals

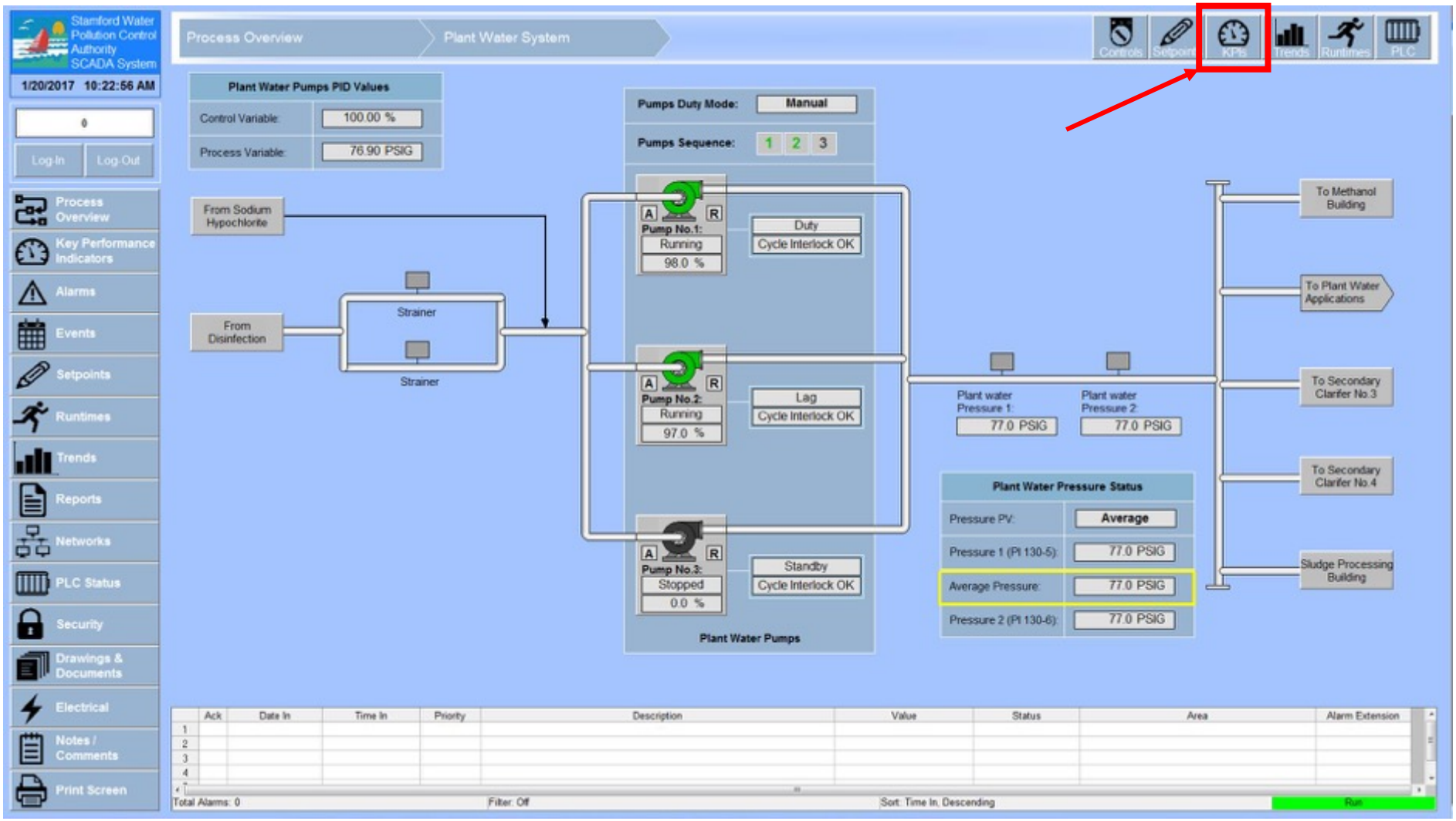
- Select replacement for legacy Honeywell Plantscape SCADA/PLCs
- Implement hardened, secure, future-proof network
- Design SCADA with the operators
- Enhance alarm management, reporting, remote notifications and links to embedded systems
- Establish standards with operations

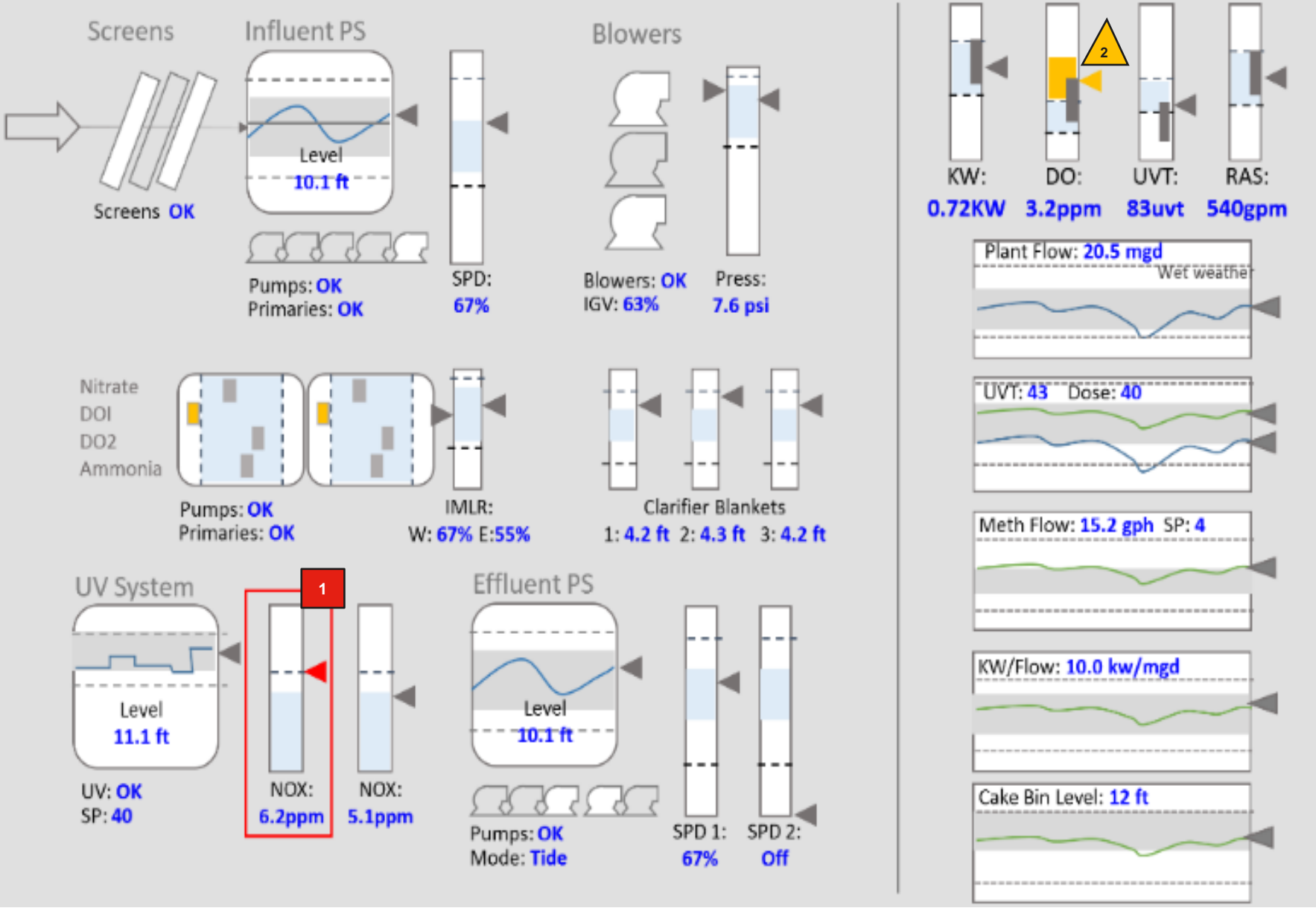
SCADA Upgrade Partnering Entities



SCADA Upgrade Partnership Process




Stamford Water Pollution Control Authority SCADA System
1/20/2017 10:22:56 AM
Log-In
Log-Out
Process Overview
Key Performance Indicators
Alarms
Events
Setpoints
Runtimes
Trends
Reports
Networks
PLC Status
Security
Drawings & Documents
Electrical
Notes / Comments
Print Screen
Process Overview
Plant Water System
Controls
Setpoints
KPIs
Trends
Runtimes
PLC
Plant Water Pumps PID Values
Control Variable: 100.00 %
Process Variable: 76.90 PSIG
Pumps Duty Mode: Manual
Pumps Sequence: 1 2 3
From Sodium Hypochlorite
From Disinfection
Strainer
Strainer
Pump No.1: Running 98.0 %
Duty
Cycle Interlock OK
Pump No.2: Running 97.0 %
Lag
Cycle Interlock OK
Pump No.3: Stopped 0.0 %
Standby
Cycle Interlock OK
Plant Water Pumps
Plant water Pressure 1: 77.0 PSIG
Plant water Pressure 2: 77.0 PSIG
Plant Water Pressure Status
Pressure PV: Average
Pressure 1 (PI 130-5): 77.0 PSIG
Average Pressure: 77.0 PSIG
Pressure 2 (PI 130-6): 77.0 PSIG
To Methanol Building
To Plant Water Applications
To Secondary Clarifer No.3
To Secondary Clarifer No.4
Sludge Processing Building
Ack
Date In
Time In
Priority
Description
Value
Status
Area
Alarm Extension
Total Alarms: 0
Filter: Off
Sort: Time In, Descending
Run



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“HIGH PERFORMANCE” HMI

HMI Components

Enterprise Systems

Remote Site Telemetry

HMI/OIT

Controllers

Packaged Vendor Systems

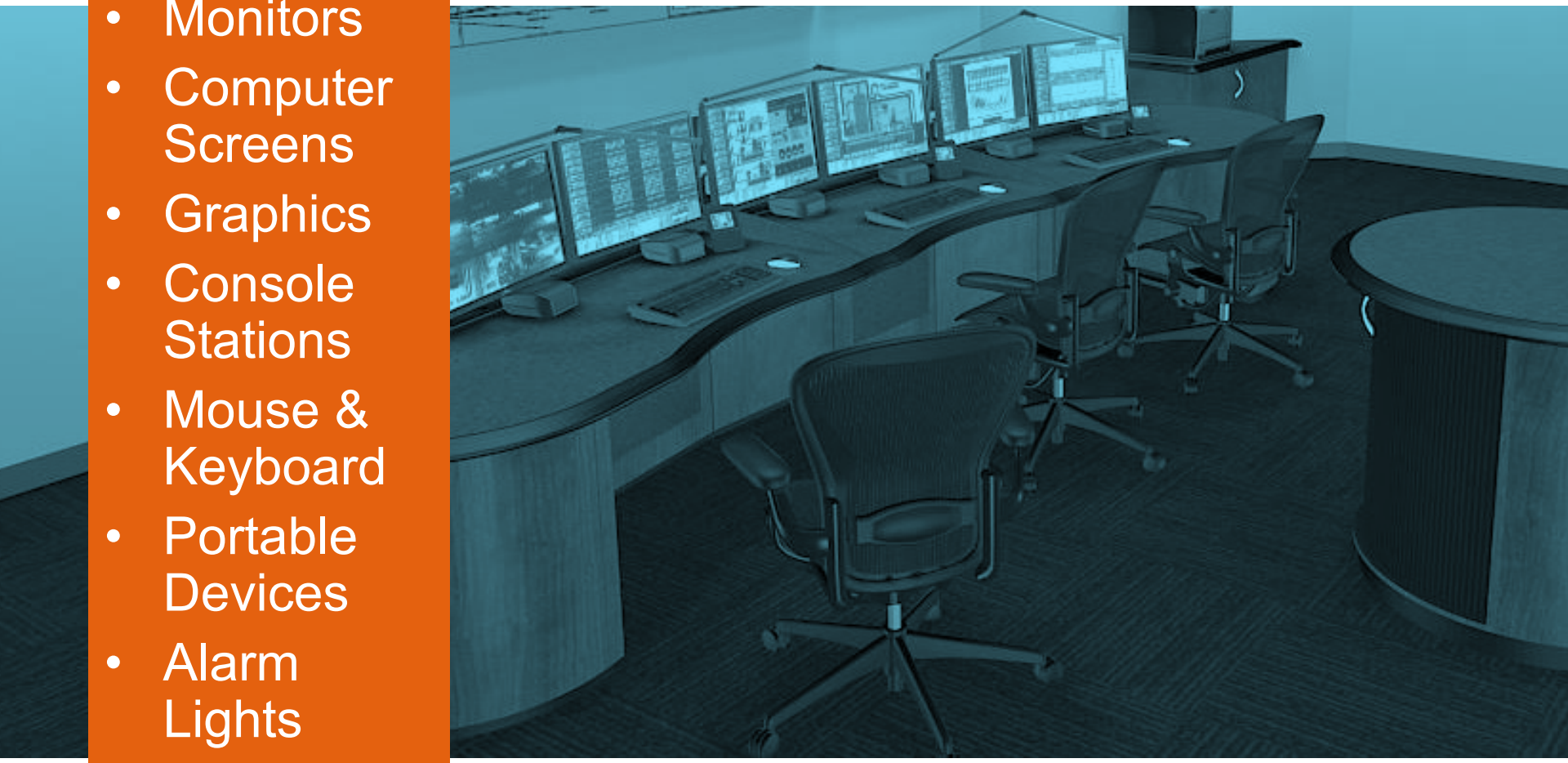
VFDs/Actuators

Field Instruments

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

The Plant Control Room

- Monitors
- Computer Screens
- Graphics
- Console Stations
- Mouse & Keyboard
- Portable Devices
- Alarm Lights
- Audible Devices



History of HMIs: …80s, early 90s

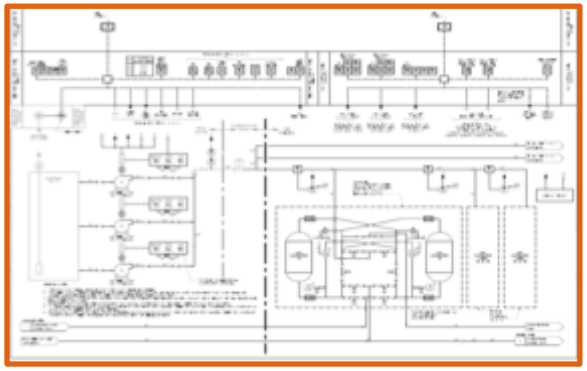
History of HMIs: 90s/00s

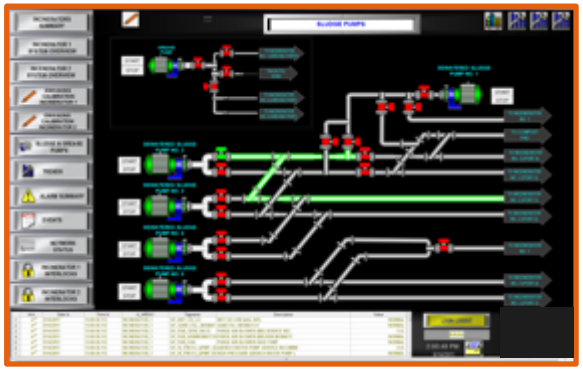
Computerized SCADA systems

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

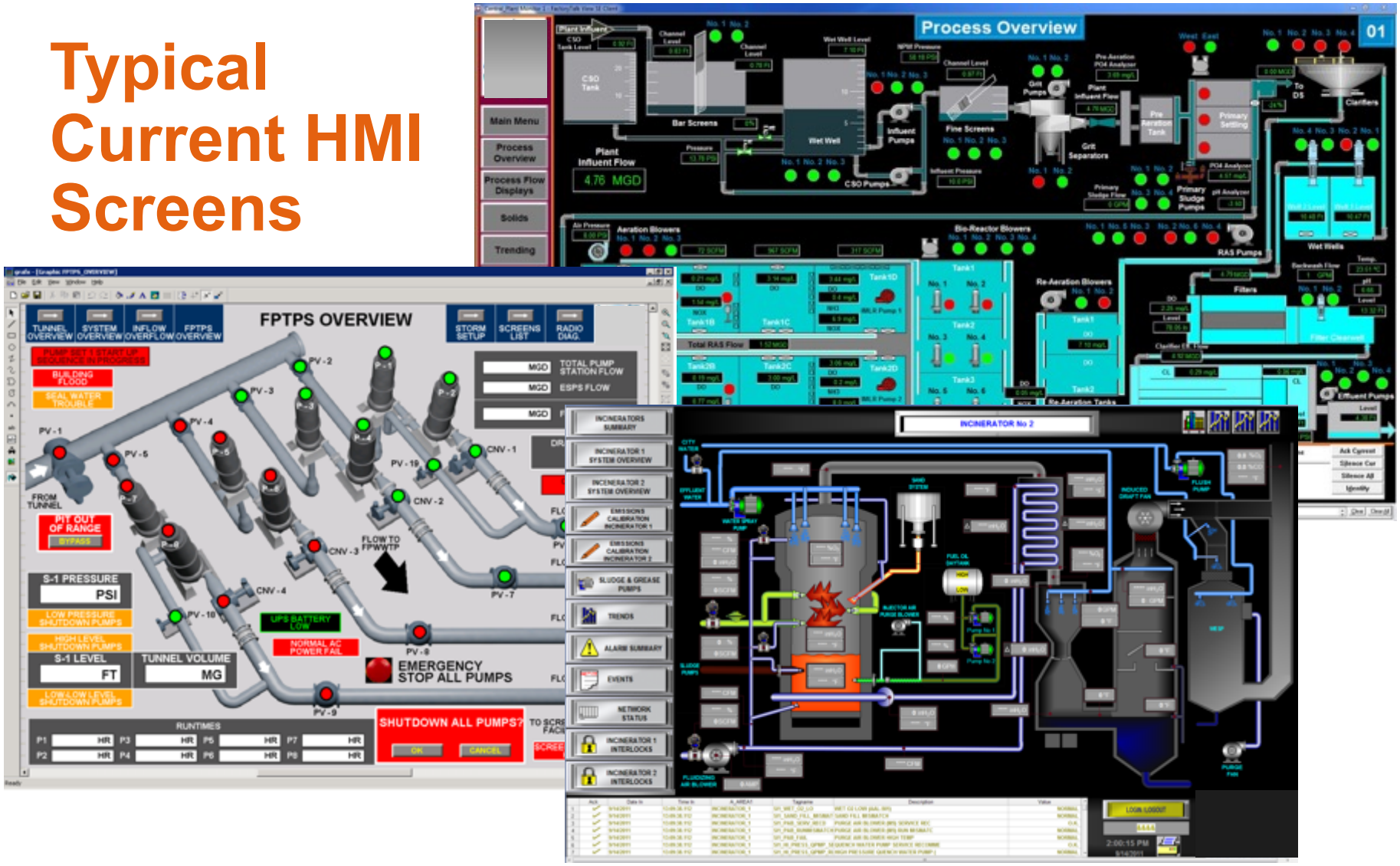
HMI software provides toolkits, features, objects, colors

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





Typical Current HMI Screens



High Performance HMI

Terms:

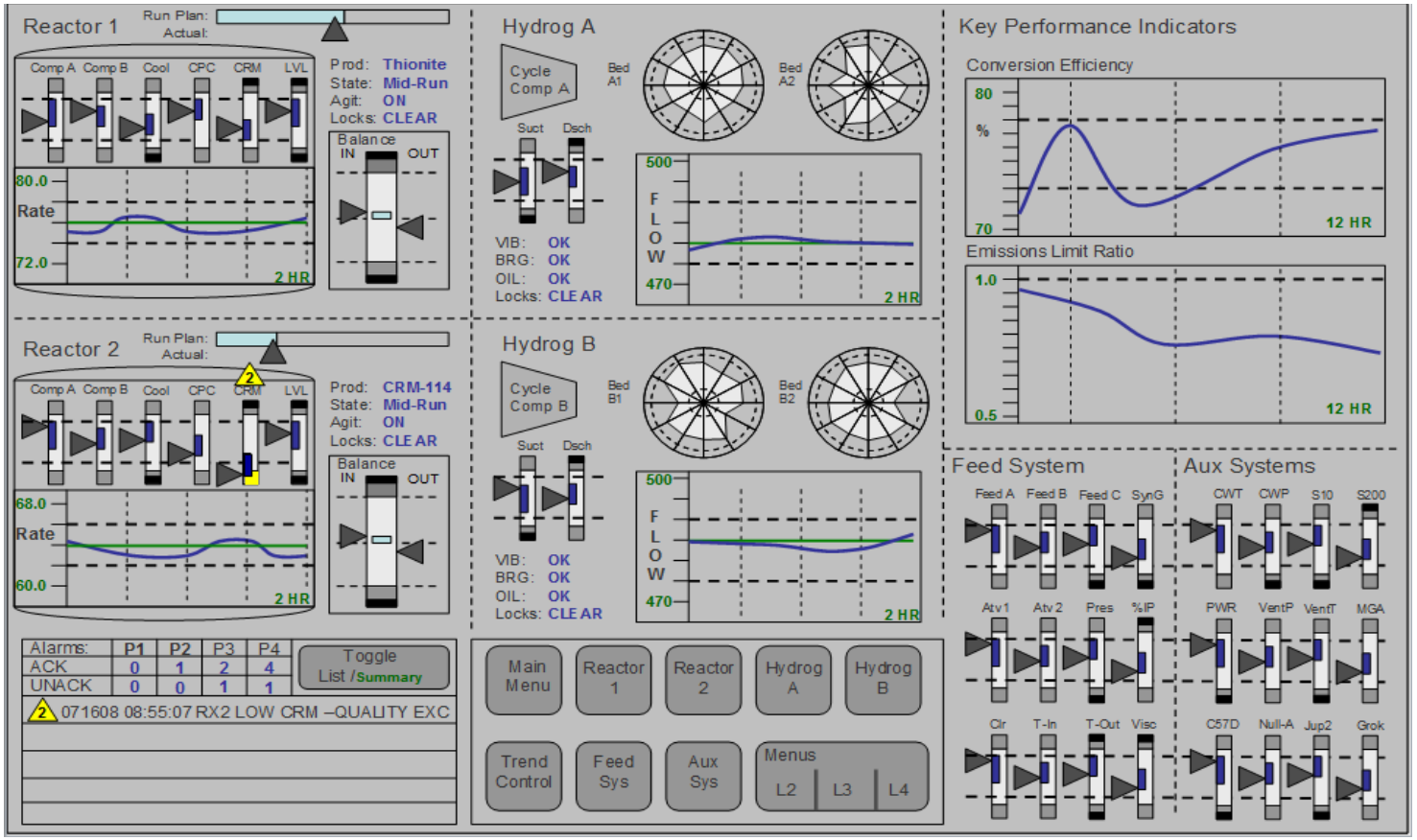
- “High Performance”
- “High Impact”
- “Next Generation”
- “Situational Awareness”

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.*

Use of Analog – Car HMI Example

Useful to the driver (operator)?

Vision



Source: HMI Handbook

Vision

Display

- Contrast
- Repetition
- Alignment
- Proximity

Graphic Development

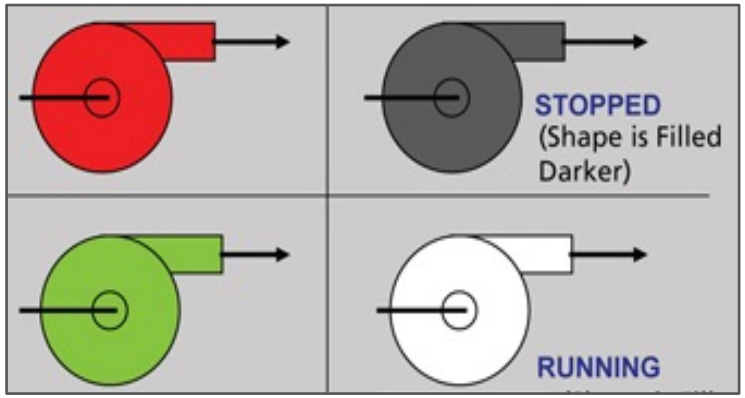
- **Use of Color and Shape**
- **Use of Patterns**
- **Use of Trends**

Source: Stock Photo

Use of Color and Shape

Use color and shape to focus attention

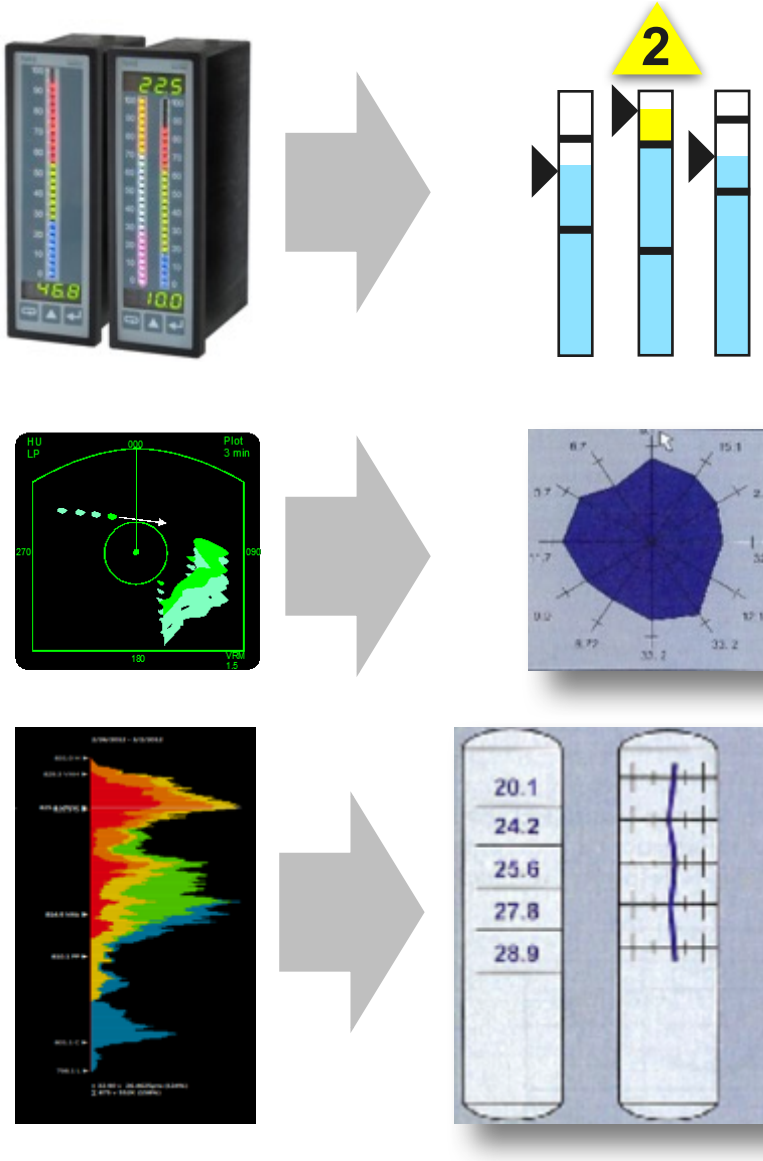
- Muted Background (Gray)
- Avoid Run/ Stop/ Open/Close Color, use contrast instead
- Indicate alarms with both color and shape



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

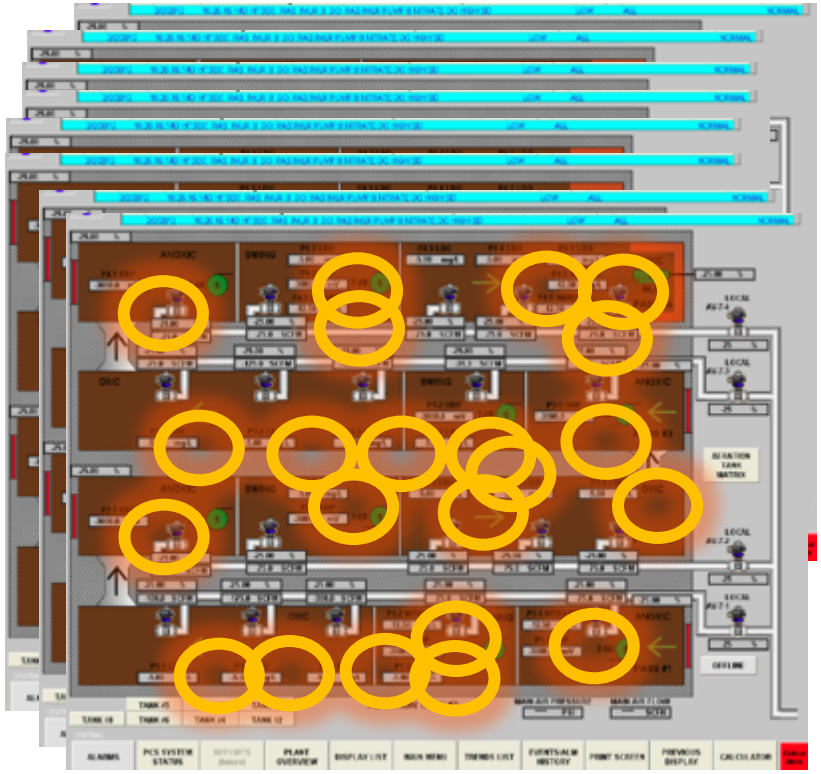


Source: The High Performance HMI Handbook (Hollifield et al., 2008].

Example – Pattern Recognition Object

BNR Unit Process

Multiple Analytical Values to review/ check



Is BNR within range?

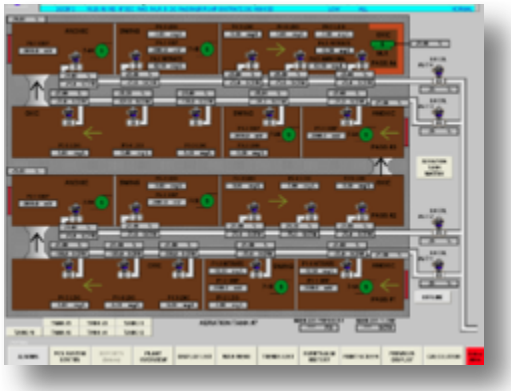
HPHMI Approach

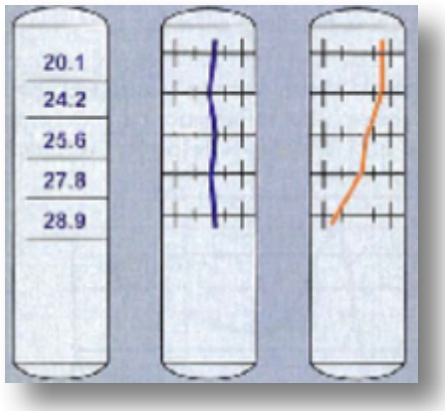
Challenges:

- “Loss of view”
- “Too much data”

Opportunities:

- PRO Object Development
- See “at-a-glance”

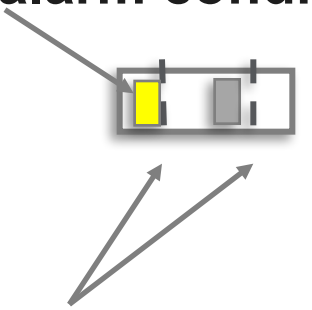




PRO in Practice

Parameter	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

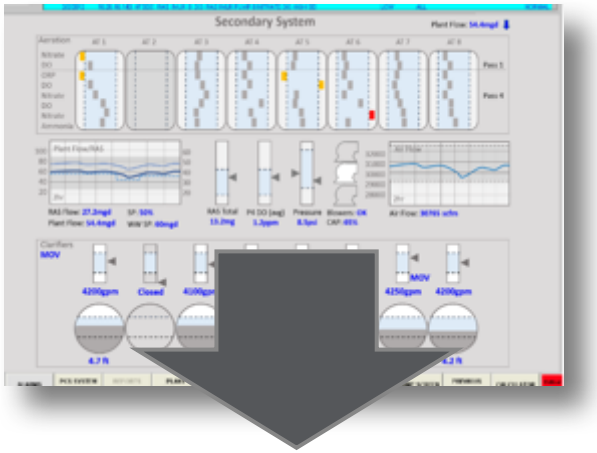
Use red for nitrate/ammonia as higher priority alarm than DO

Example – Tier 2 – Unit Process

Entire Secondary

Profile Displays

- DO, Nitrate, Nox
- RAS, etc.



Is BNR within range?

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*

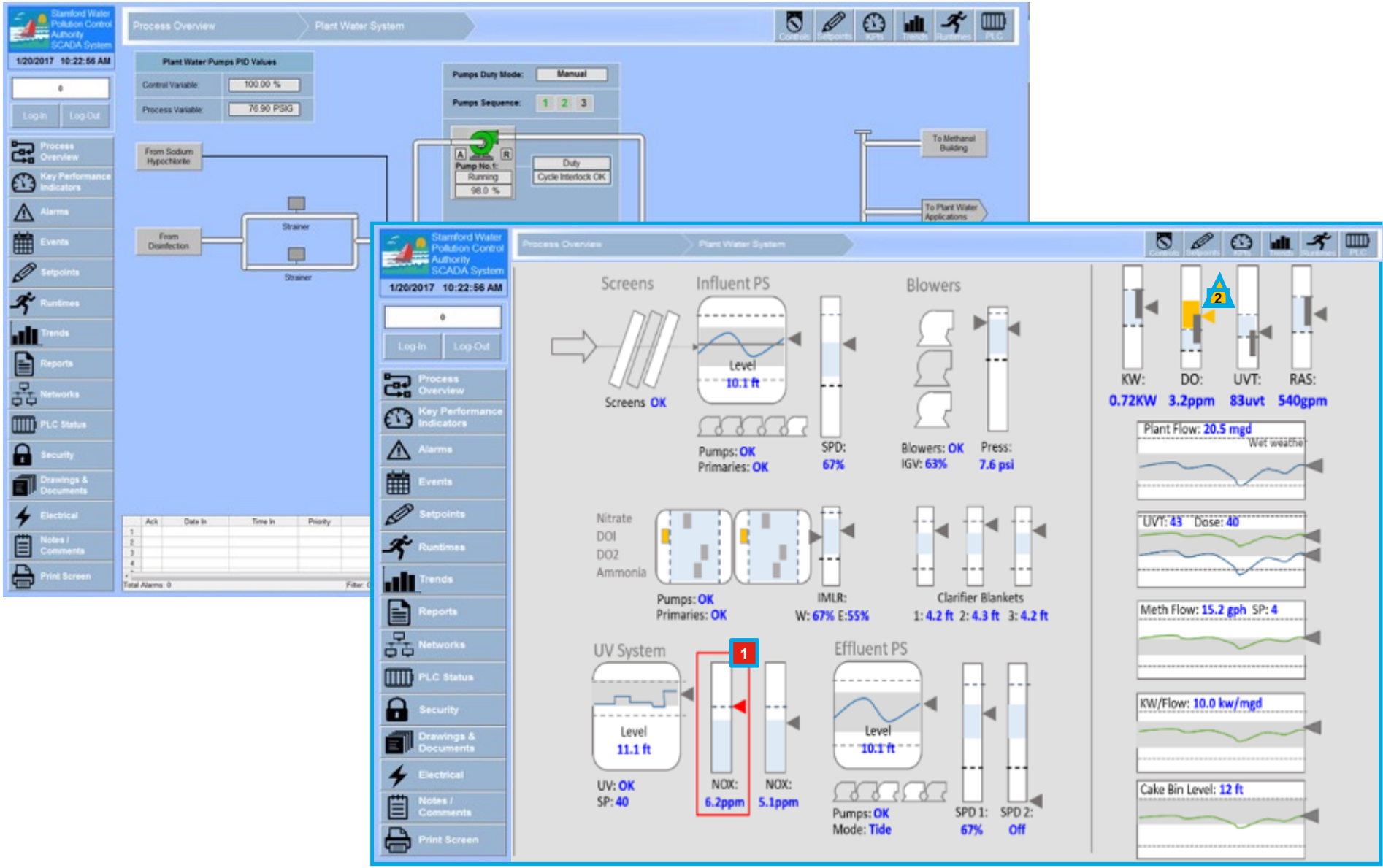
ISO 9241 *Ergonomic requirements for office work with display terminals*

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*

CONCLUSIONS



Conclusions

- Set the SCADA vision and goals together.
- Control Room Environment critical to SCADA success
- Design SCADA with operator mental model; be willing to change the way you think of SCADA
- Work together to think about how and if elements of HPHMI will improve operational “view”
- Side-by-side introduction of HPHMI with traditional screens
- Enhance alarm management, reporting, remote notifications and links to embedded systems

Conclusions: Benefits of HPHMI

Before

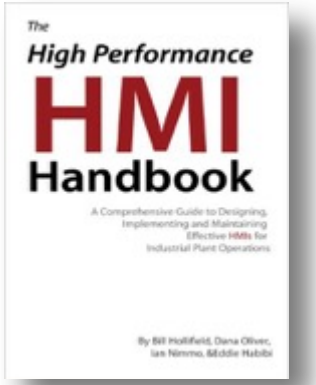
- Engineer and software features drives design
- Ineffective overview of processes
- Emphasis on numerical displays
- Little use of embedded trending
- Poor use of color
- Too many alarms to handle

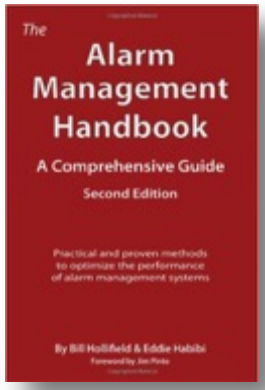
After

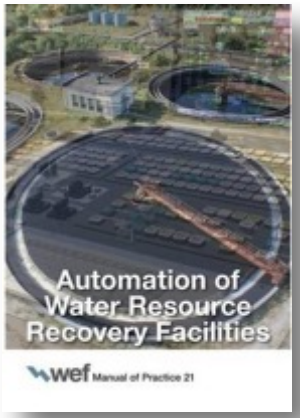
- Design driven by operator mental model
- Effective “at-a-glance” process overviews
- Emphasis on analog displays and patterns
- Effective use of roadmap trending
- Appropriate use of color
- Alarms properly rationalized

Increasing situational awareness & effectiveness of HMI

References







- ANSI/ISA-101.01-2015, Human Machine Interfaces for Process Automation Systems
- ANSI/ISA-18.2-2009 Management of Alarm Systems for the Process Industry
- The High Performance HMI Handbook *by Bill Hollifield, Dana Oliver, Ian Nimmo, Eddie Habibi, PAS 2008*
- The Alarm Management Handbook: A Comprehensive Guide by Bill Hollifield and Eddie Habibi, 2006
- Effective Console Operator HMI Design: Second Edition - Revised (ASM Consortium Guidelines) 2nd Edition, *by ASM Consortium.*
- Automation of Water Resource Recovery Facilities - MOP 21 (WEF Manual of Practice) *Water Environment Federation*

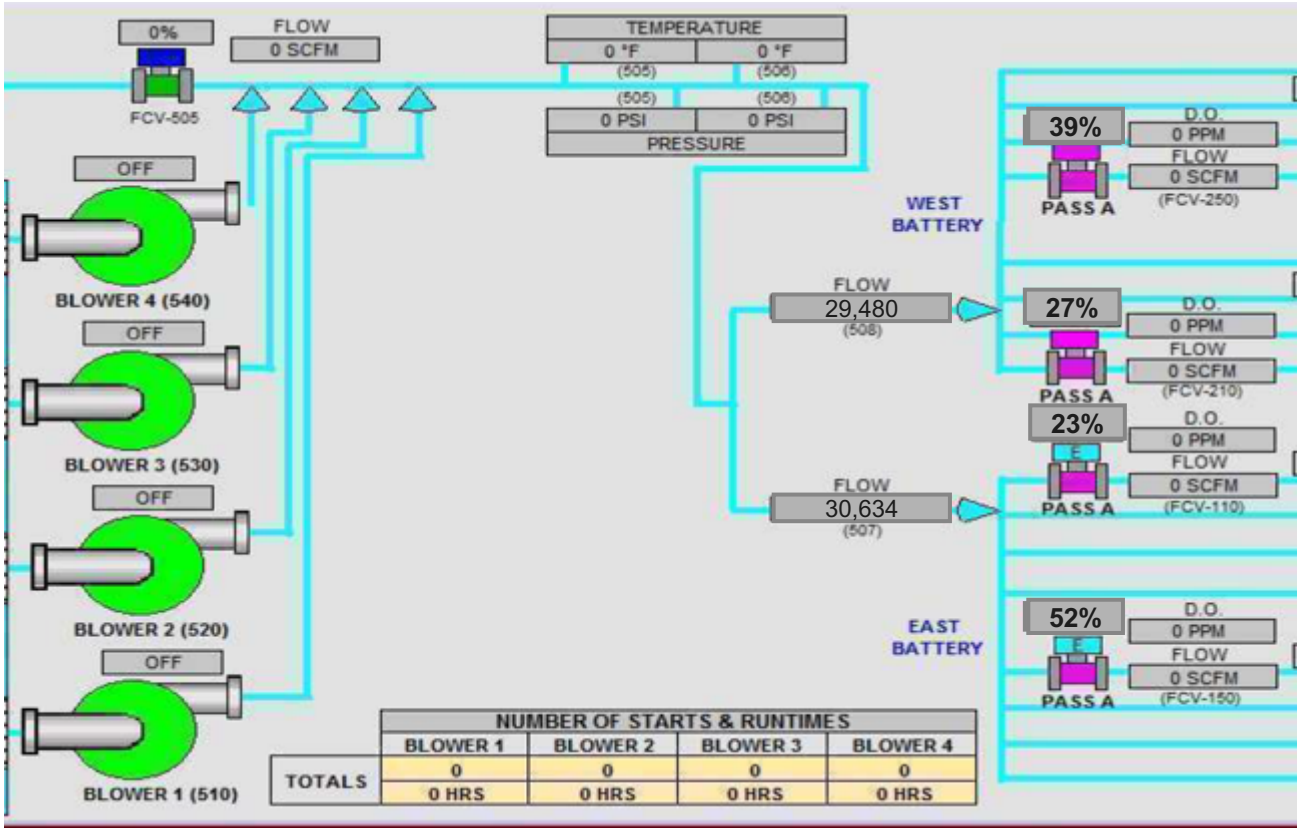
Q&A

Example – Tier 2 – Unit Process

Process Air Unit Process

Header Distribution

MOV Control/ Balance



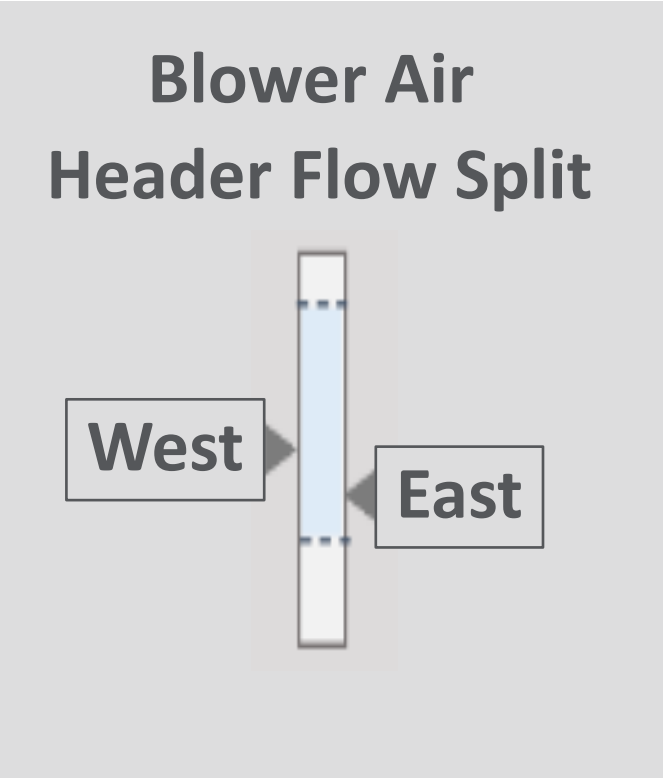
Is flow balanced?

Example – Tier 2 – Unit Process

Process Air
Unit Process

Header Distribution

MOV Control/ Balance



Is flow balanced?