

High Performance HMI

ISA-101 and ISA-18.2 in the iFIX environment

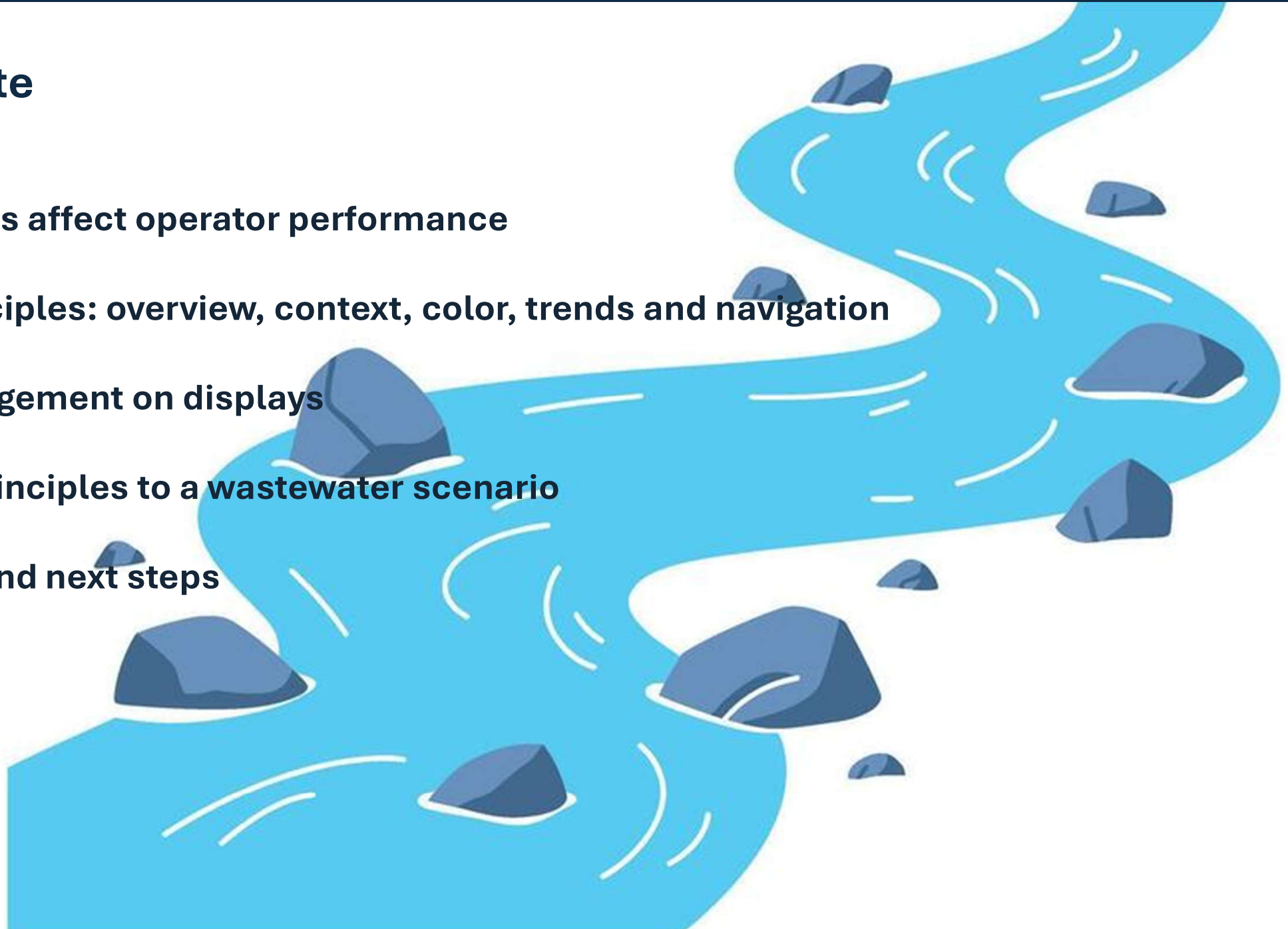


Workshop objectives

- Recognize graphics that support operator situation awareness
- Apply a practical ISA-101 display hierarchy to water and wastewater operations
- Connect alarm presentation on graphics to ISA-18.2 alarm management
- Identify a realistic path to improve an existing iFIX HMI

Today's route

- **Why graphics affect operator performance**
- **Design principles: overview, context, color, trends and navigation**
- **Alarm management on displays**
- **Apply the principles to a wastewater scenario**
- **Questions and next steps**





The operator's job

- Understand what the process is doing now
- Recognize when conditions are moving away from normal
- Decide whether action is required and what action is appropriate
- Coordinate across the control room, field staff and procedures
- The HMI is one part of the operating system. Alarm management, control-system performance, procedures and training also matter.

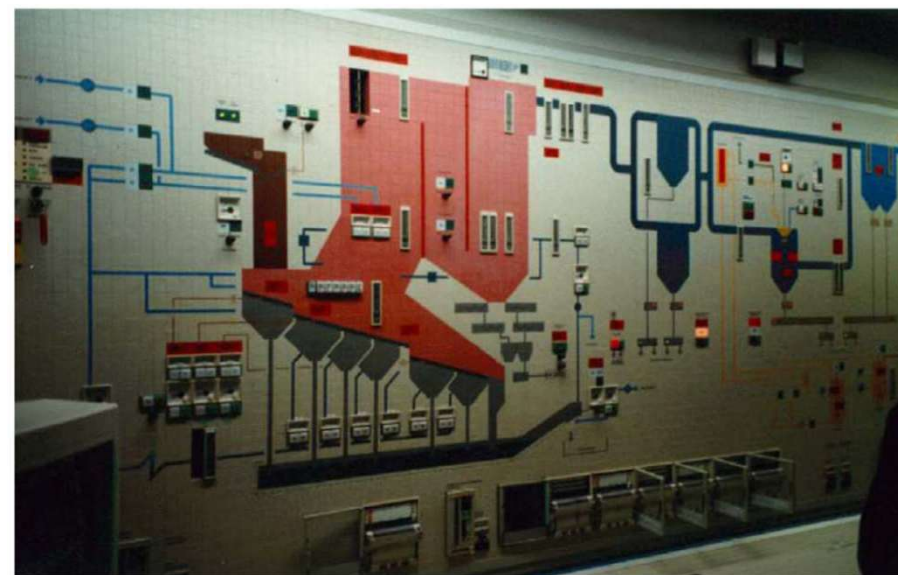
- The Three Components
 - Effective Alarm Management
 - Control System Performance
 - **High Performance HMI**
- Effective Operations Requires all three aspects
- Effective Abnormal Situation Management also requires all three
- Operator vigilance involves the ENTIRE HMI – not just the alarm system





HMIs Past

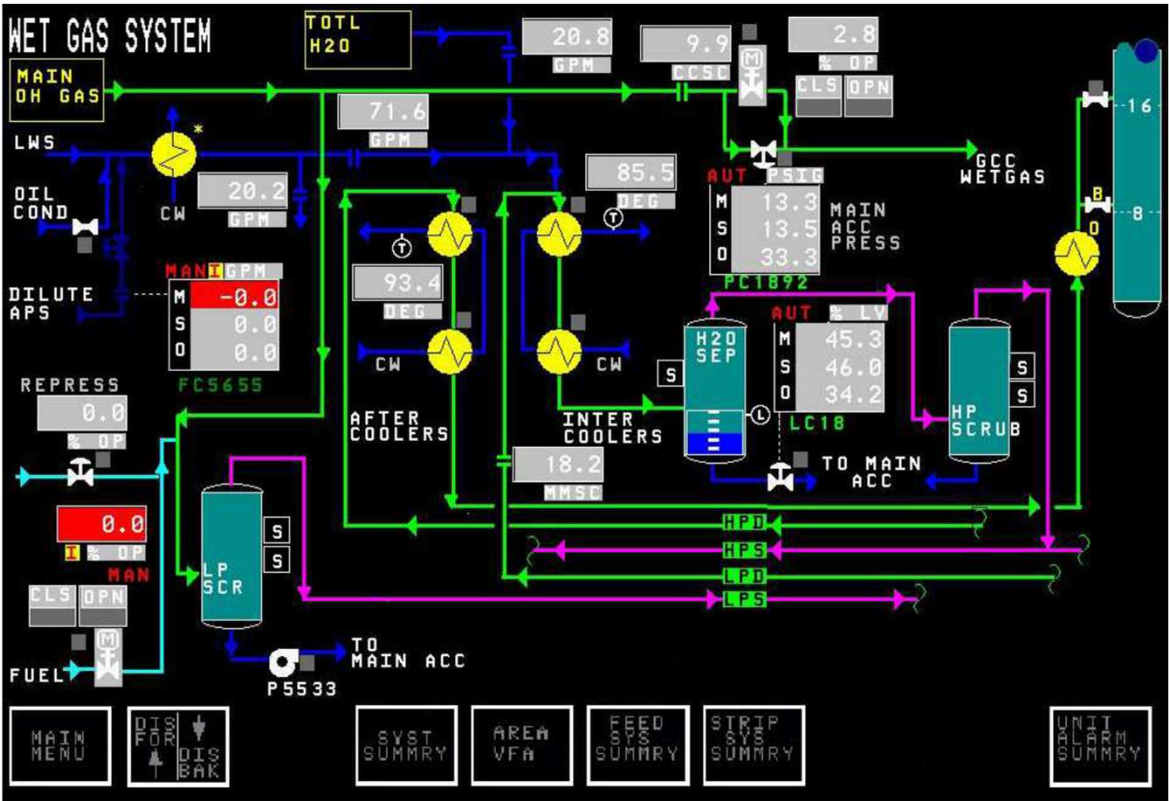
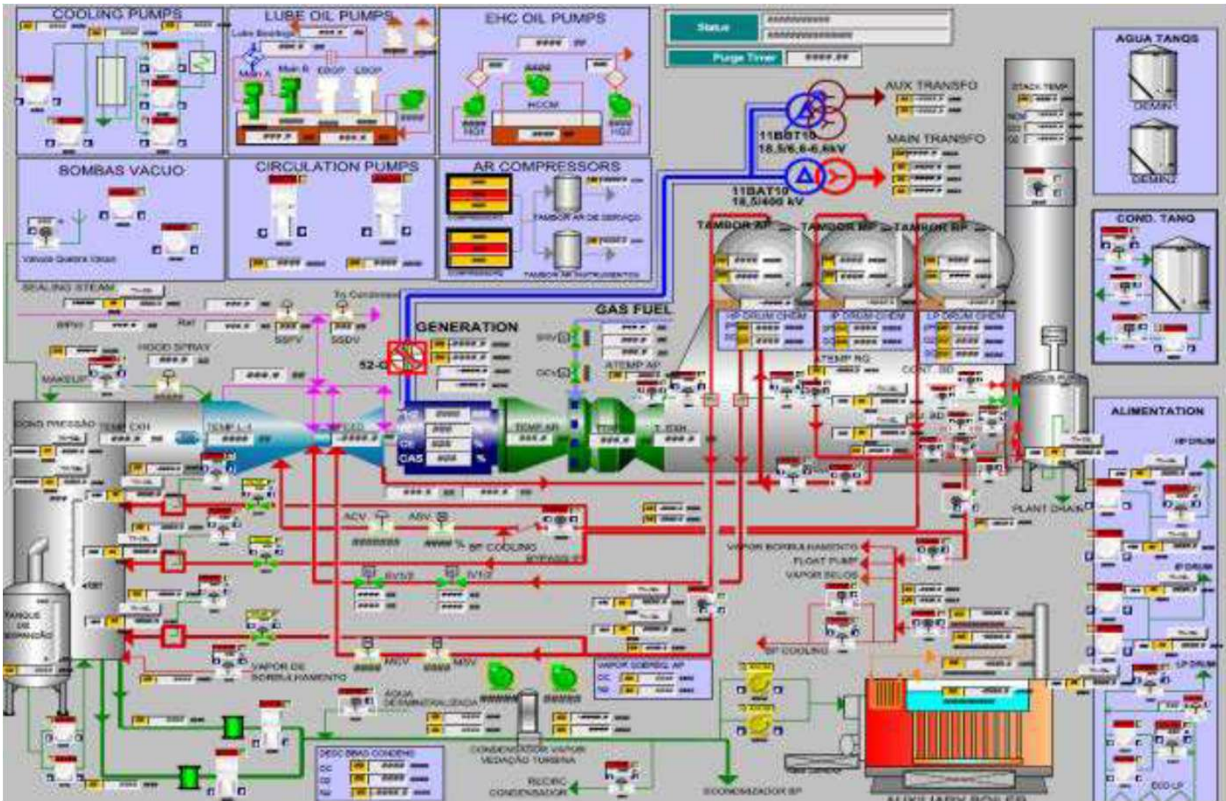
- Remember the “old days”?
- Provided the “Big Picture”
- Limited Capability
- Many Process Trends
- Status “at-a-glance”
- (but took years to learn)





SCADA Graphics Introduced

no guidelines = Poor Graphics = Poor Operating Practices

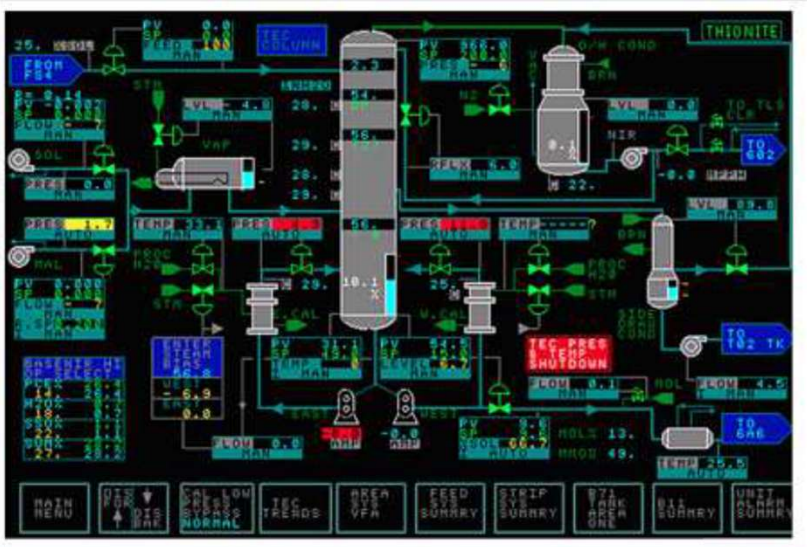




Common, Ineffective HMI Depictions

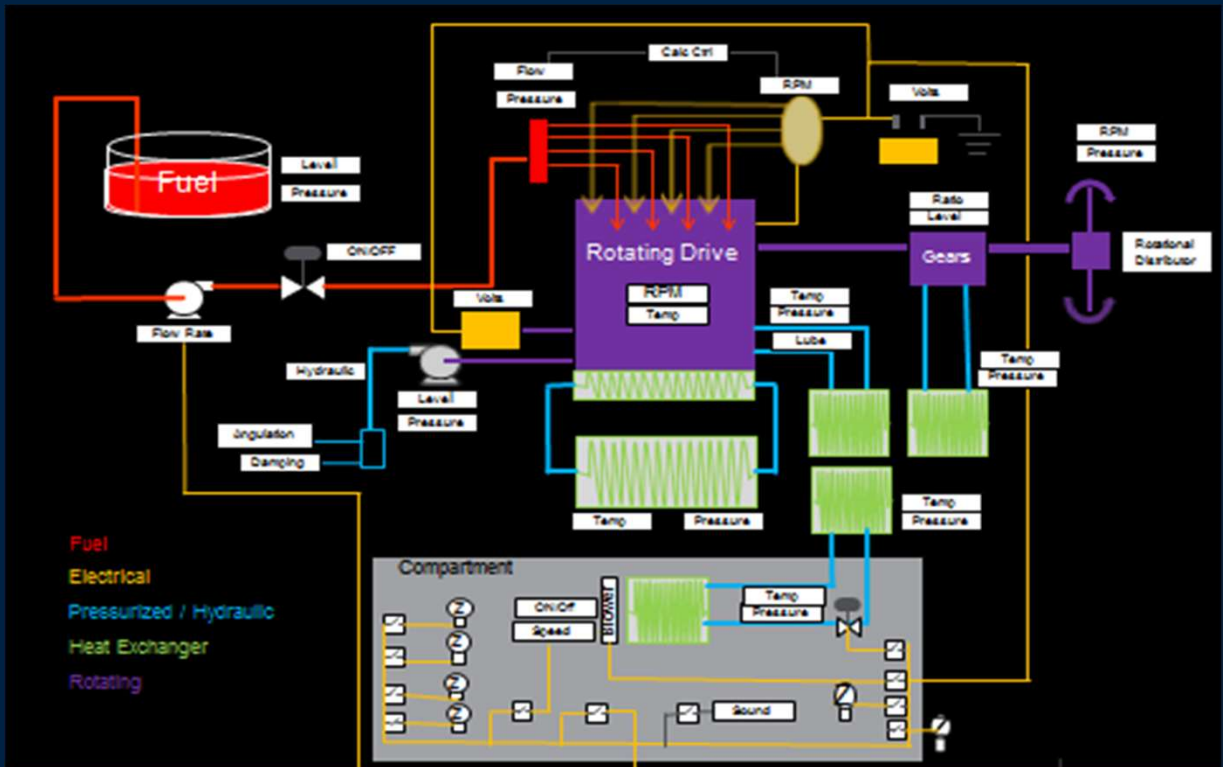
- Common, but ineffective process depictions
- Numbers sprinkled on a screen
- Inconsistent, improper use of color
- No trends, no condition information

Are these processes running well?





Name this process ???



How about now ...



... Did you guess right?



Situation Awareness in Aviation

Example is the Garmin GTN-650 small aircraft display system



Speed
Altitude
Position
Course
Nearby Airports

Time Enroute
Time to next
Waypoint
Time to
Destination

Fuel Remaining
Proximity to
Ground
Proximity to
Rising Terrain

Positions of
nearby aircraft
Real-time
weather &
lightning

Engine
diagnostics
Data on Available
Services at
Airports

Comm & Nav
Frequencies
Instrument
Approaches
Glide Radius



High Performance displays

Principles

- Show the process relationship, not just the instrument list
- Make abnormal conditions visible without making normal conditions noisy
- Provide context that supports an operating decision
- Keep interaction consistent across screens
- Test the display with operators doing real tasks

Philosophy

- Define who uses each display and what work it supports
- Set rules for color, symbols, alarm indications, navigation and interaction
- Agree on display types and information hierarchy
- Document ownership, review and approval responsibilities
- The philosophy makes design choices repeatable across projects and upgrades

Data becomes useful with context

- A value alone answers: “What is the instrument reading?”
- Operating context adds: units, normal range, critical range, trend, mode and equipment state
- The operator can then judge whether the value needs attention
- Example: chlorine residual 0.75 mg/L needs a target range, trend and process location to guide a response



Blood Tests for Spot	
Test	Results
HCT	31.7%
HGB	10.2 g/dl
MCHC	32.2 6/dl
WBC	9.2 x10 ⁹ /L
GRANS	6.5 x10 ⁹ /L
L/M	2.7 x10 ⁹ /L
PLT	310 x10 ⁹ /L

Example adapted from High Performance Handbook



Blood Tests for Spot			
Test	Results	Range	Indicator
			Low - Normal - High
HCT	31.7%	24.0 – 45.0	<div><div></div><div></div><div></div></div>
HGB	10.2 g/dl	8.0 – 15.0	<div><div></div><div></div><div></div></div>
MCHC	32.2 6/dl	30.0 - 36.9	<div><div></div><div></div><div></div></div>
WBC	9.2 x10 ⁹ /L	5.0 – 18.9	<div><div></div><div></div><div></div></div>
GRANS	6.5 x10 ⁹ /L	2.5 – 12.5	<div><div></div><div></div><div></div></div>
L/M	2.7 x10 ⁹ /L	1.5 – 7.8	<div><div></div><div></div><div></div></div>
PLT	310 x10 ⁹ /L	175 - 500	<div><div></div><div></div><div></div></div>

Example adapted from High Performance Handbook

Show analog values with operating context

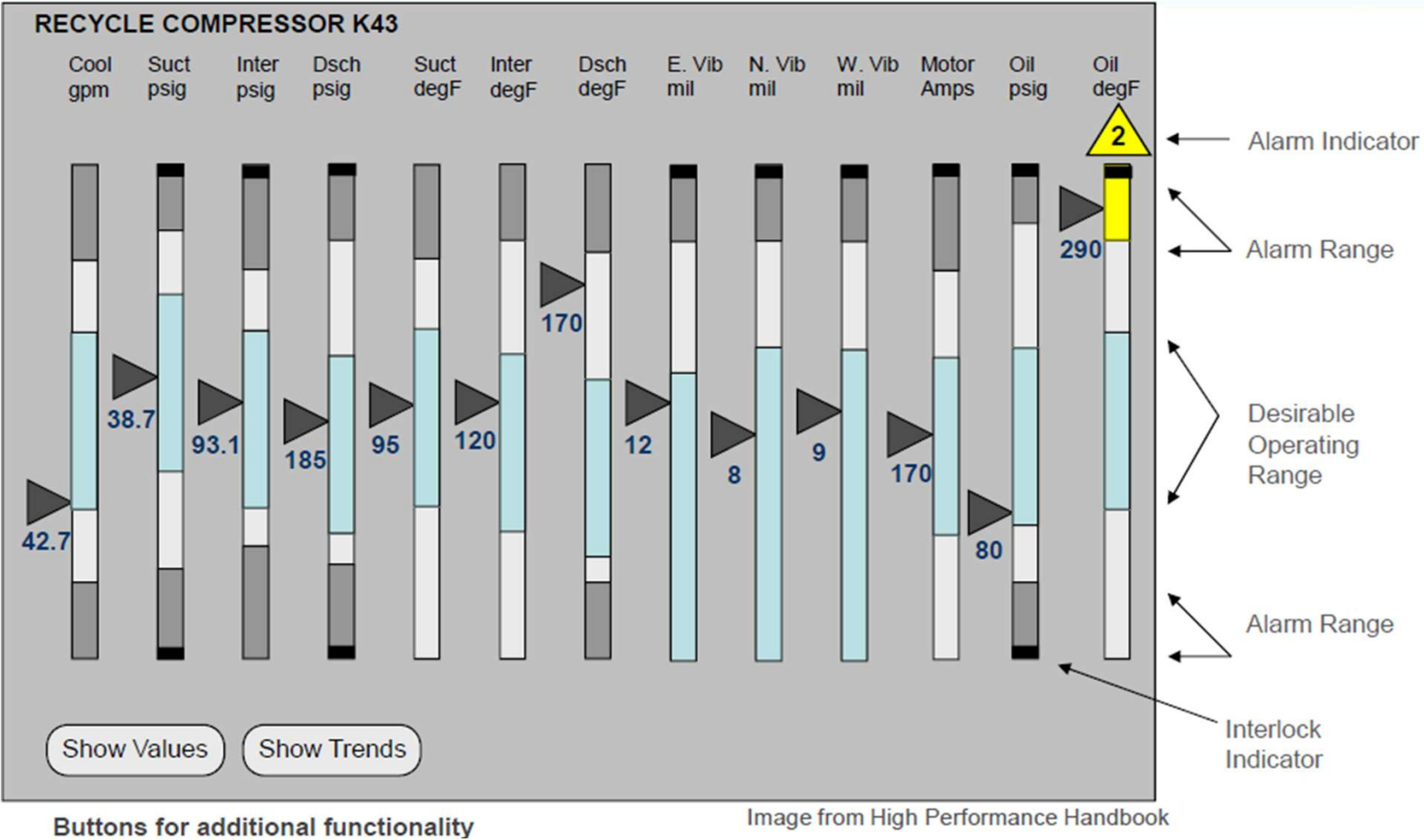
Show the value and engineering units

Provide normal and critical operating ranges where they help decisions

Indicate alarm, interlock or permissive state clearly

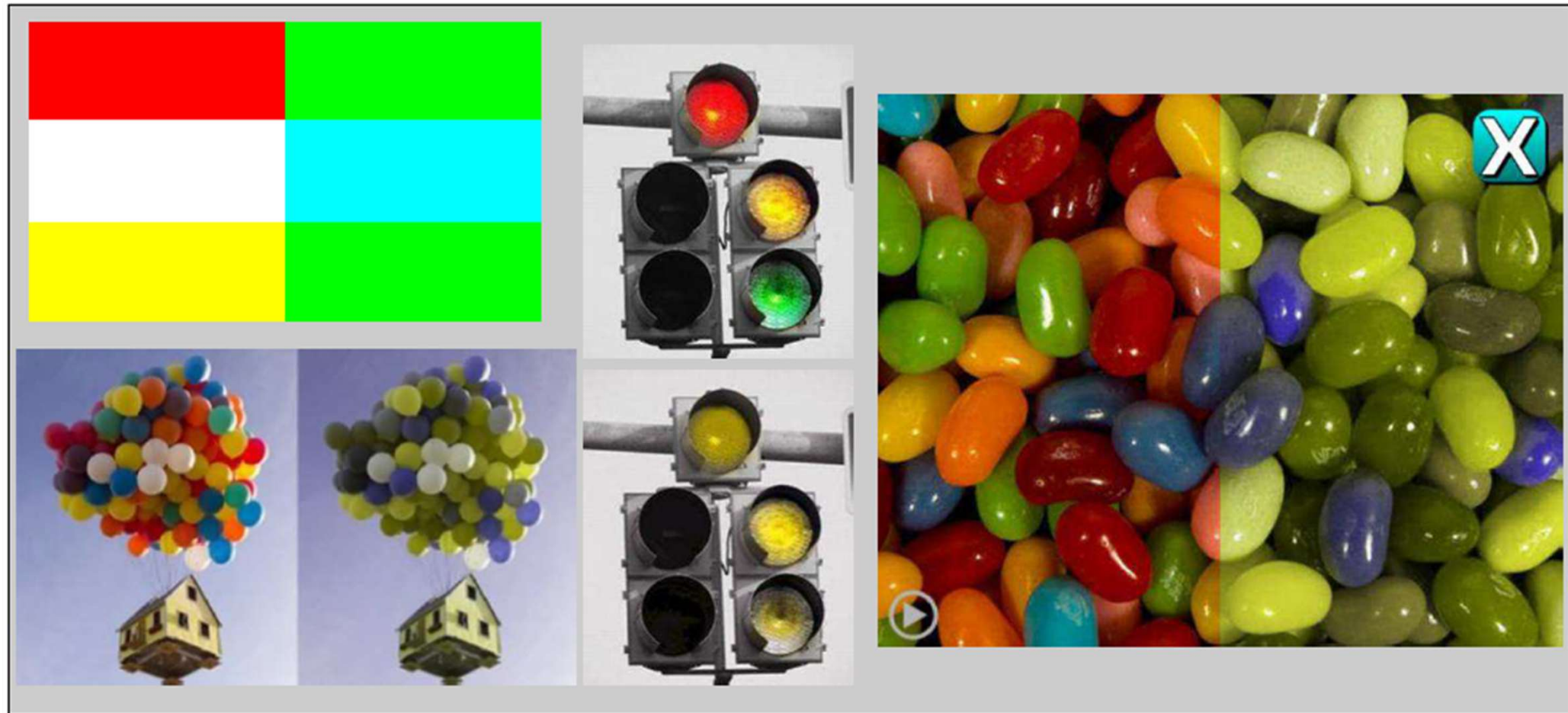
Use a small trend when recent direction matters

Avoid decorative gauges that use space without improving interpretation



Common Color Blindness or Deficiency

- Very common, different types
- Color change is not detected well in peripheral vision.
- Color alone should not be used to differentiate an important status!



What makes a graphic hard to use?

Every device looks active because color and animation appear everywhere

Numbers lack ranges, trends or relationships to the process

Important exceptions compete with decoration

Navigation follows the designer's equipment model instead of the operator's tasks

SCREEN A



SCREEN B

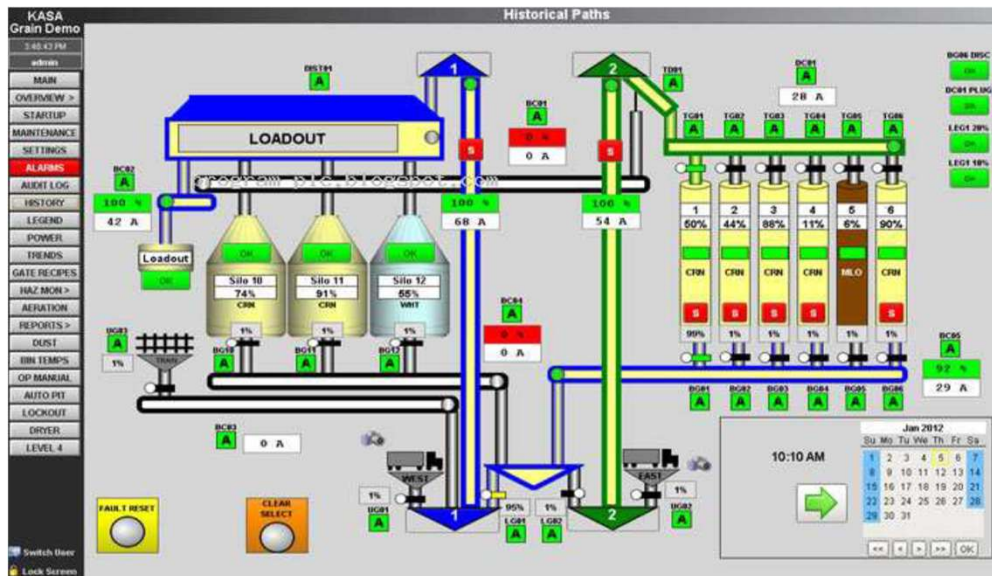
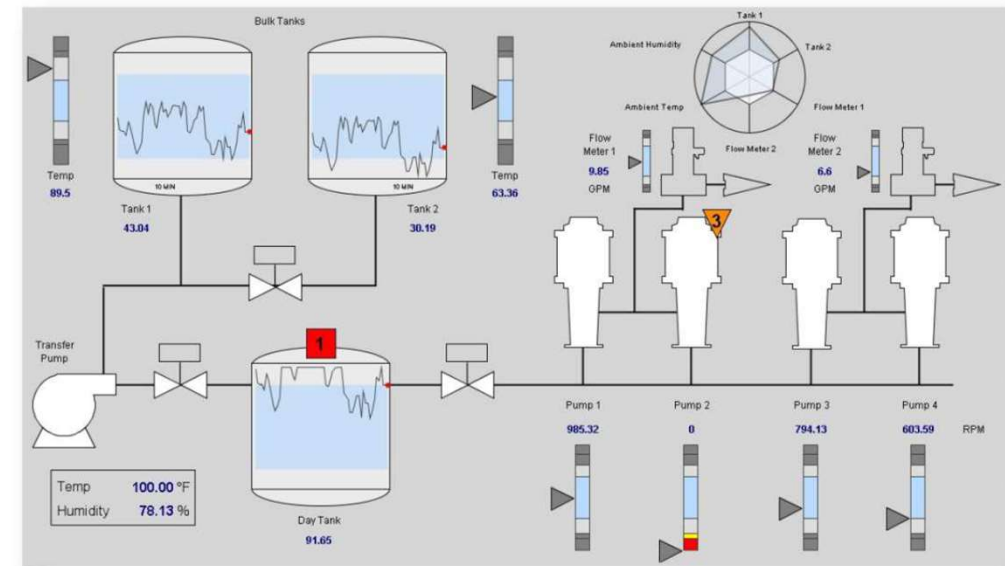


Normal states recede. Exceptions attract attention.

Color and visual attention

- Use neutral colors for normal process equipment and background information
- Reserve saturated color for abnormal conditions, alarms or selected states
- Use color consistently with the alarm philosophy
- Avoid relying on color alone. Pair color with text, shape, position or pattern
- Check contrast and color-vision accessibility

What parts of the screens catch your eye?



Display hierarchy

- Level 1: the operator's full span of control and overall condition
- Level 2: area or process overview and the primary operating interface
- Level 3: equipment detail or task display for non-routine work
- Level 4: diagnostic information, interlocks and troubleshooting
- Display level describes information scope. Navigation may use a different number of steps.

Level 1

System overview

Level 2

Process area

Level 3

Equipment / task

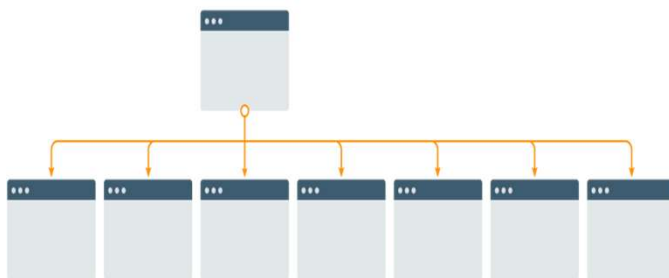
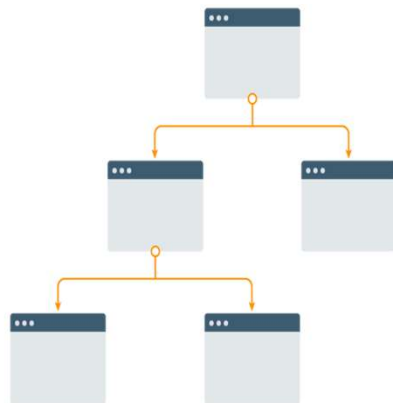
Level 4

Diagnostics

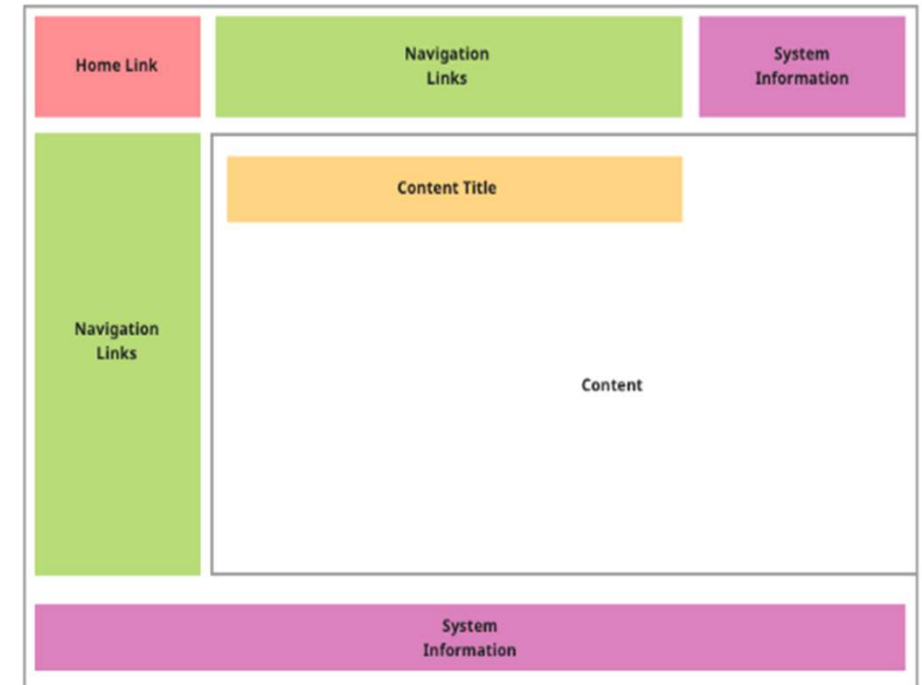
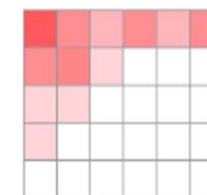
Navigation should follow the work

- Keep the current location visible
- Group displays by plant area, process and operator task
- Make common destinations easy to reach
- Provide direct links from alarms and process symbols to relevant detail
- Use consistent names and interaction patterns across iFIX screens

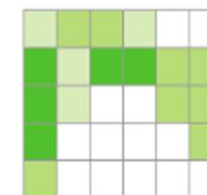
Broad and Shallow



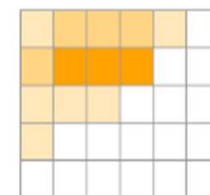
Narrow and Deep



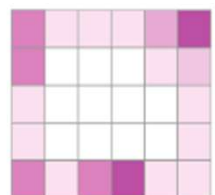
Home Link



Navigation Links



You Are Here/Titles



System Information

Water and wastewater display hierarchy

- Level 1: utility-wide status across plants, pump stations, storage and treatment
- Level 2: plant or process area, such as influent, aeration, disinfection or solids handling
- Level 3: pump, basin, filter, blower, chemical feed or unit process
- Level 4: instrument diagnostics, permissives, interlocks and maintenance detail
- Use the operator's assigned span of control to set the actual boundaries.

A useful Level 1 overview

Show the condition of the whole assigned system at a glance

Represent process flow and key dependencies clearly

Include critical status, priority alarms and relevant operating measures

Show trend direction where it changes interpretation

Keep detailed commands and diagnostics on lower level displays

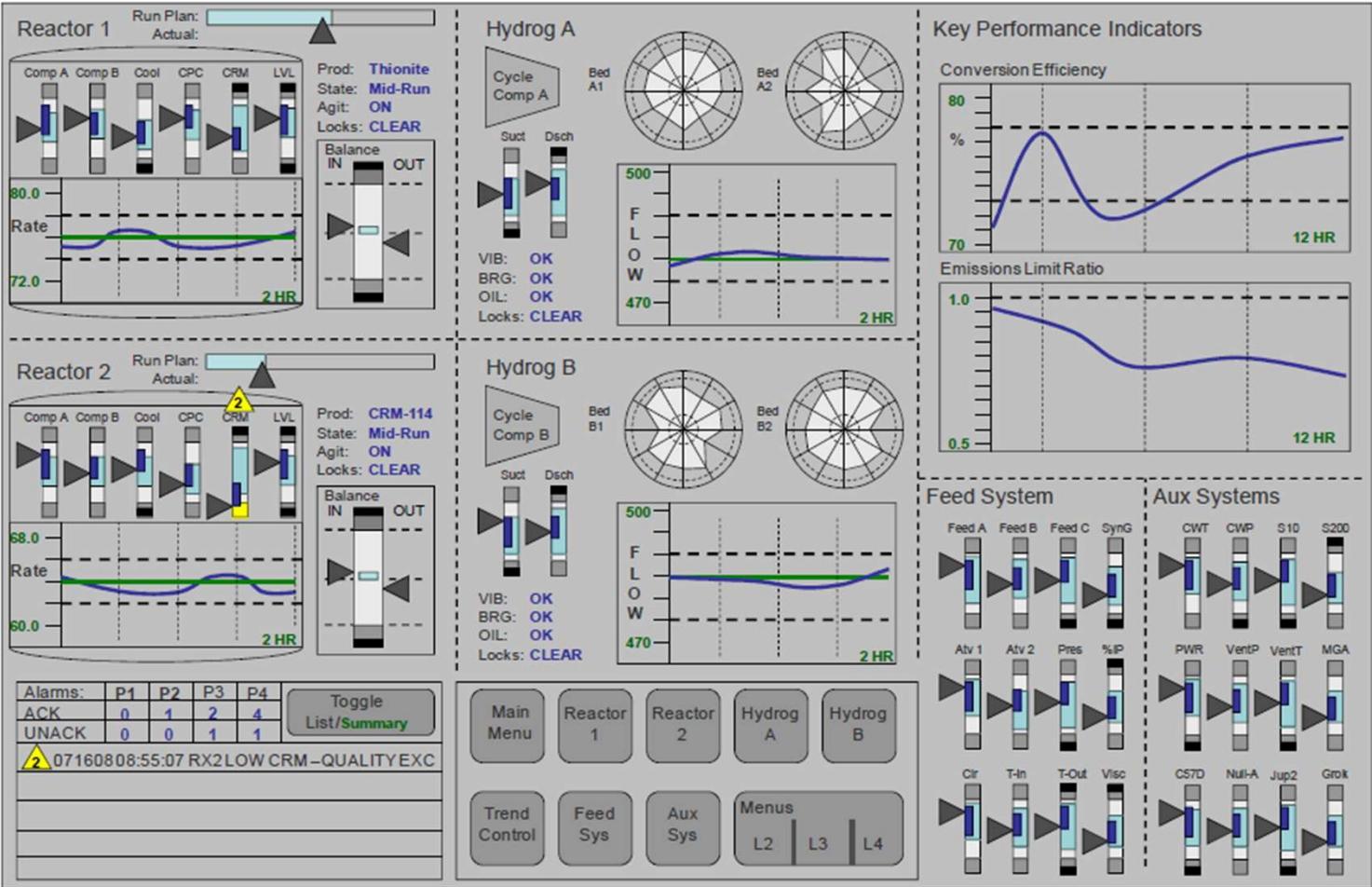
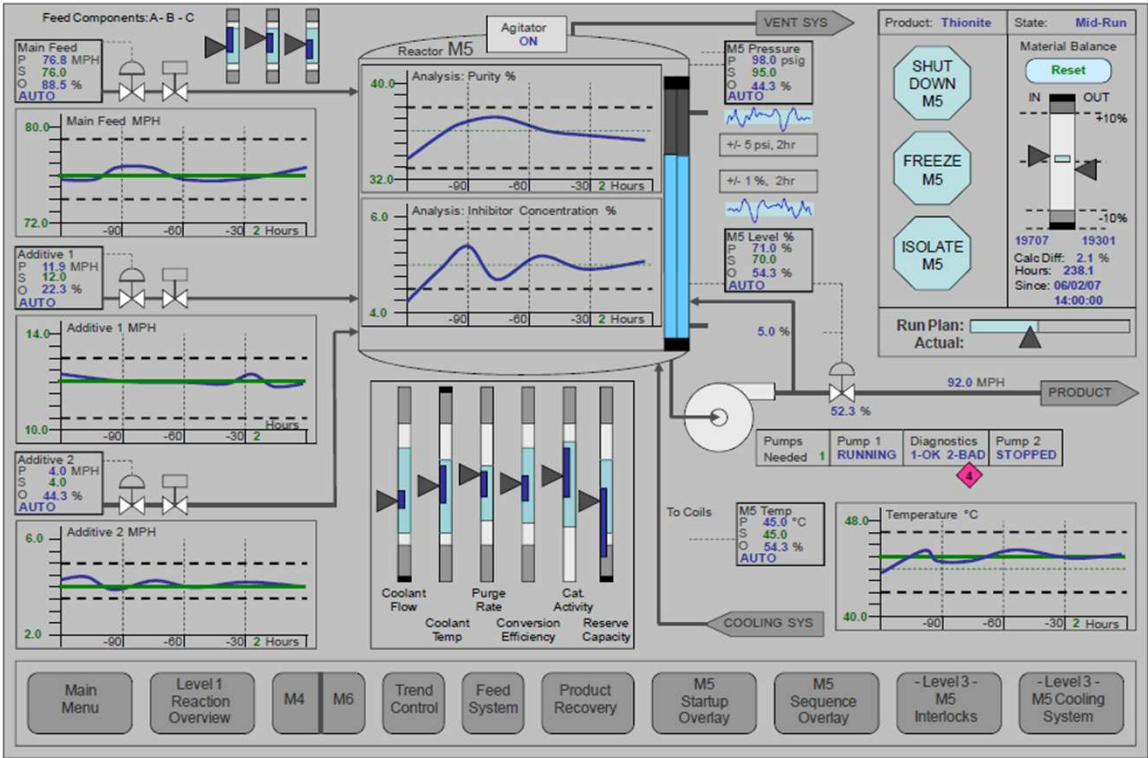


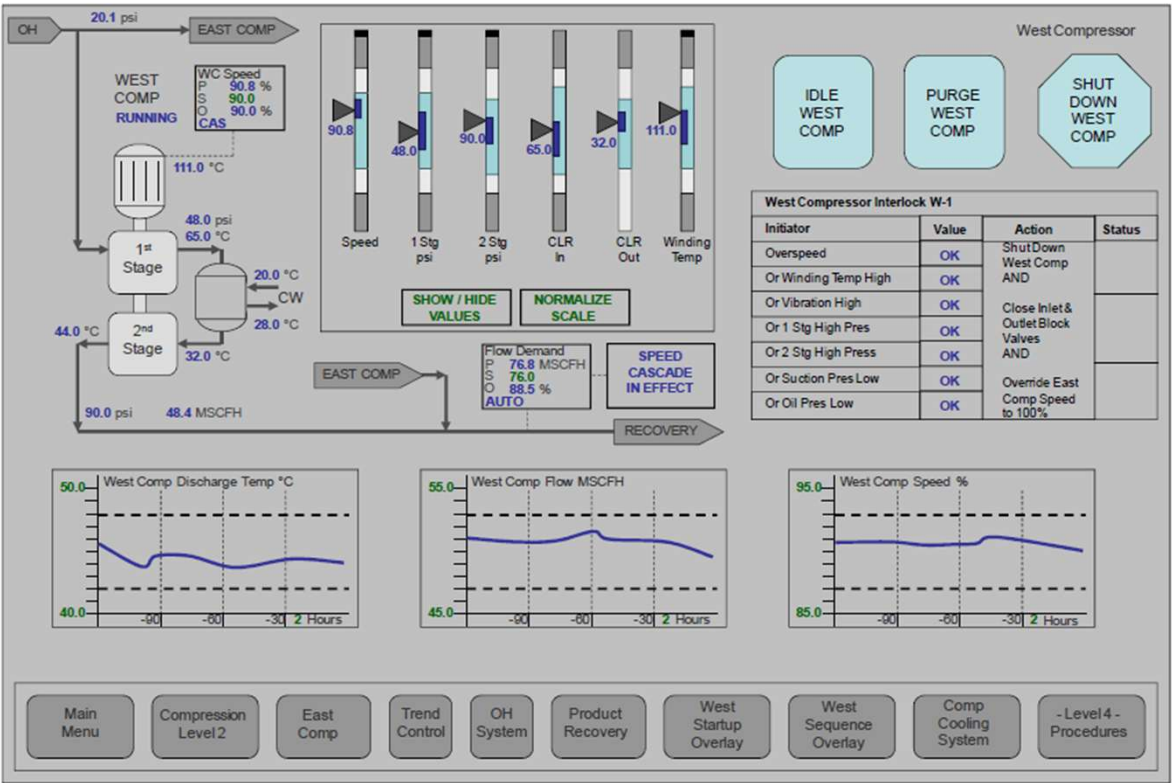
Image from High Performance Handbook

Control of a Process Sub-Part

Level 2



Level 3



Notice... it's not the P&ID Diagram

Trends reveal changing conditions

- A single reading may look normal while the process is deteriorating
- Embed short trends for variables operators need to monitor continuously
- Use a clear time span, units and scale
- Link to a detailed trend for investigation
- Water examples: wet-well level, pump flow, chlorine residual, turbidity, dissolved oxygen, RAS flow

Embedded “always visible” trends on process displays are always better.

Don’t rely on “trending on demand”, “trend pop-ups” or “trend screens” –in practice they don’t work very well.

Sparklines

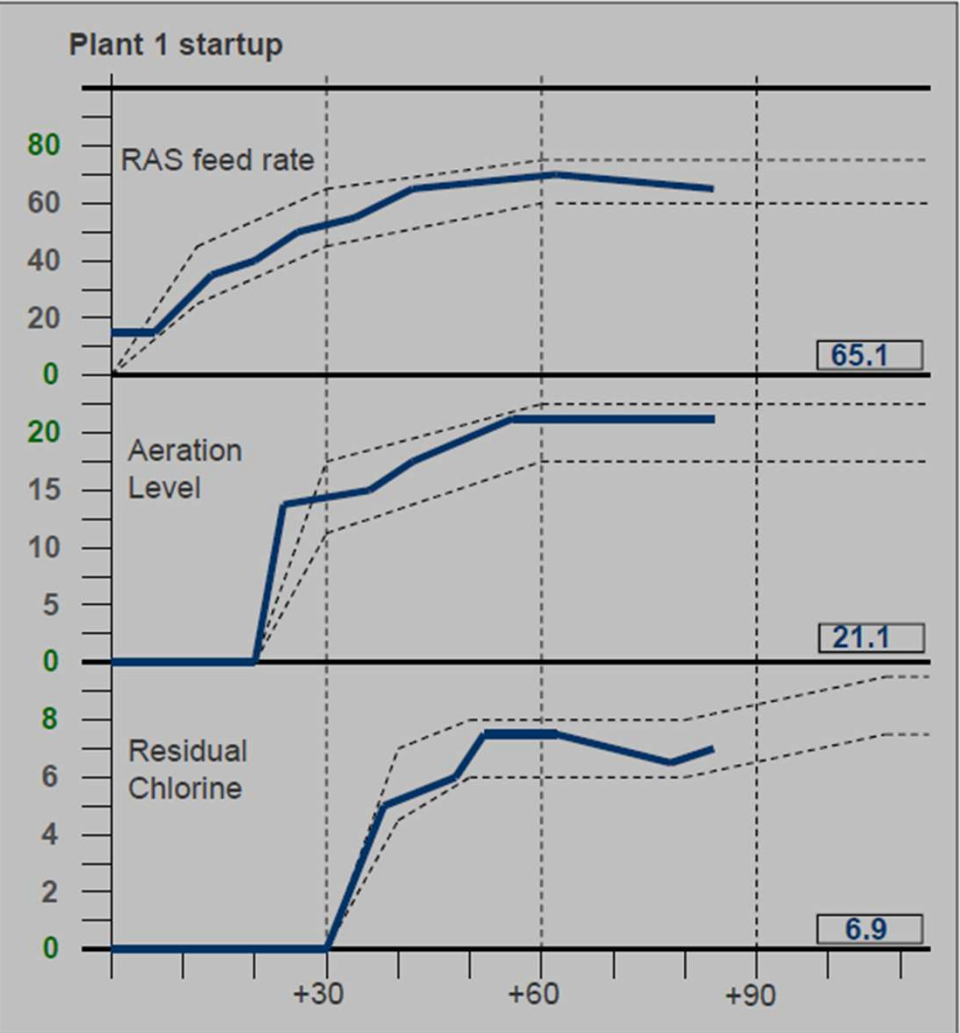


Minimalistic chart component that displays a line-chart history for a single datapoint

Show contextual information in a very small amount of space

Typically used to display the recent history to quickly discern the recent trend

More concepts with Trending



Would these trends help you startup the process...

Functional grouping beats a map alone

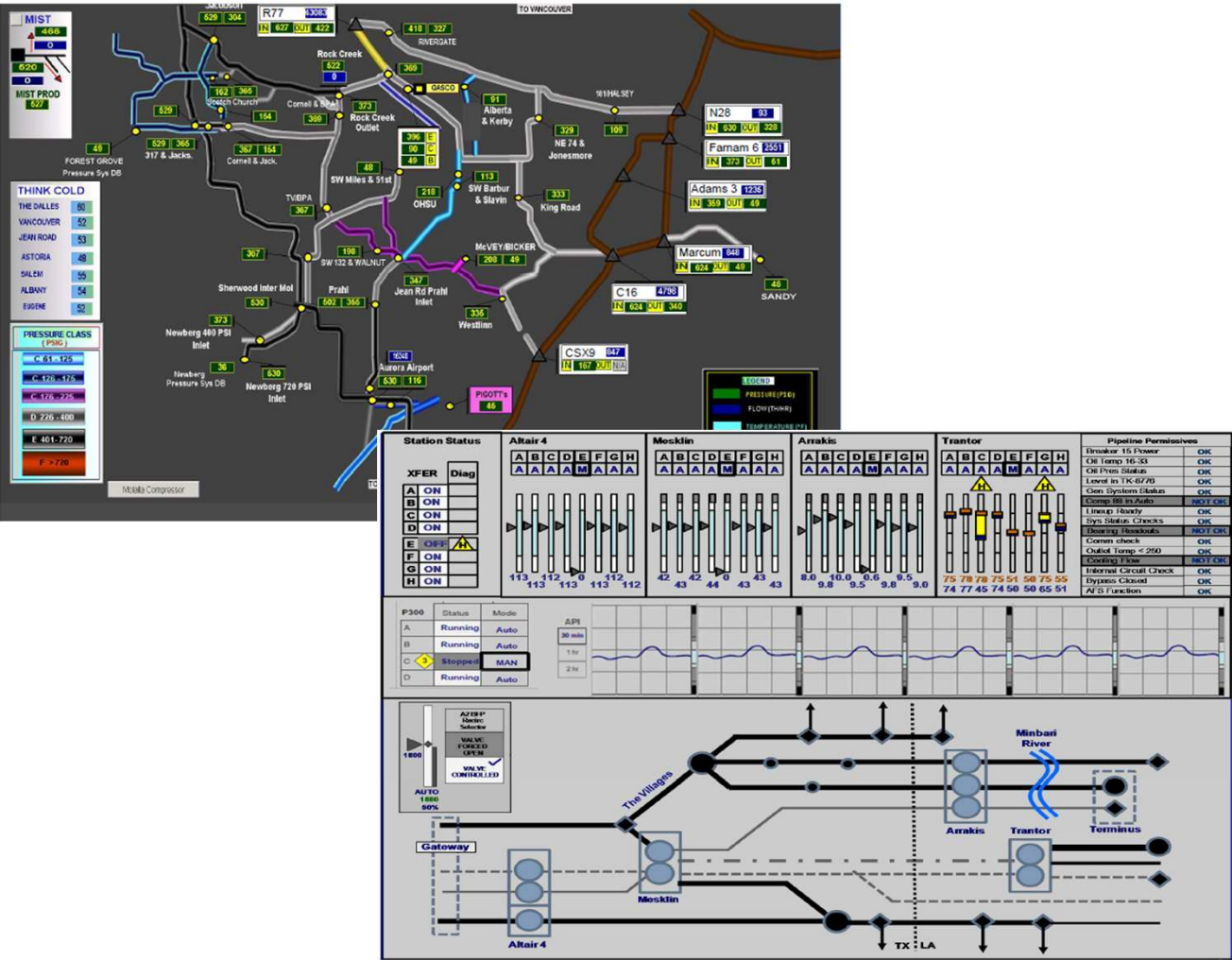
Geography helps locate assets and field crews

Process function helps operators understand what is happening

Group screens around work: collection, pumping, treatment, disinfection, discharge

Use maps only as a complement when location, route or remote-site status matters

Operators preferred a functional grouping over a plan view that did not match their mental model



ISA-101: a managed HMI lifecycle

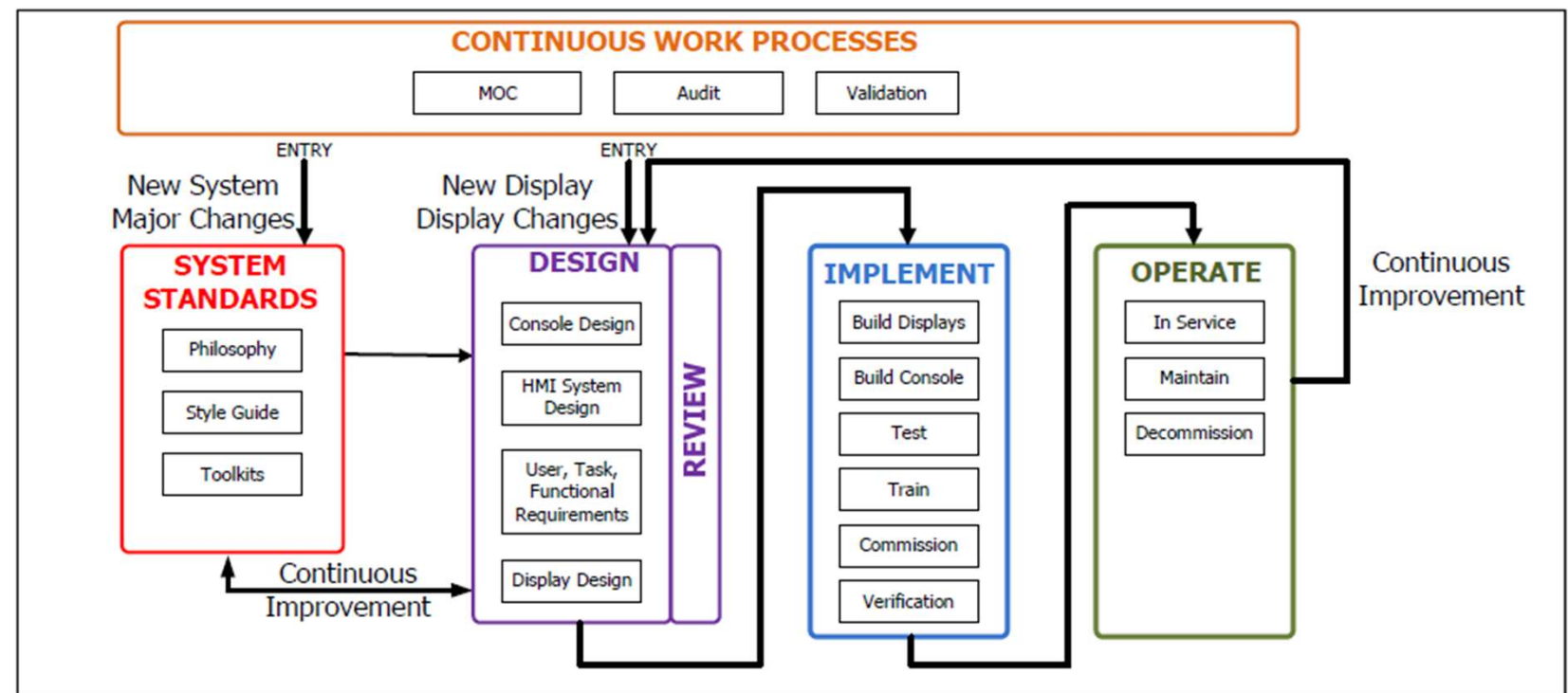
Define an HMI philosophy and design basis

Create a style guide and reusable toolkit

Design around users, tasks and functional requirements

Build, test, train, commission and maintain

Use management of change, audits and continuous improvement





Reusable graphics in iFLX

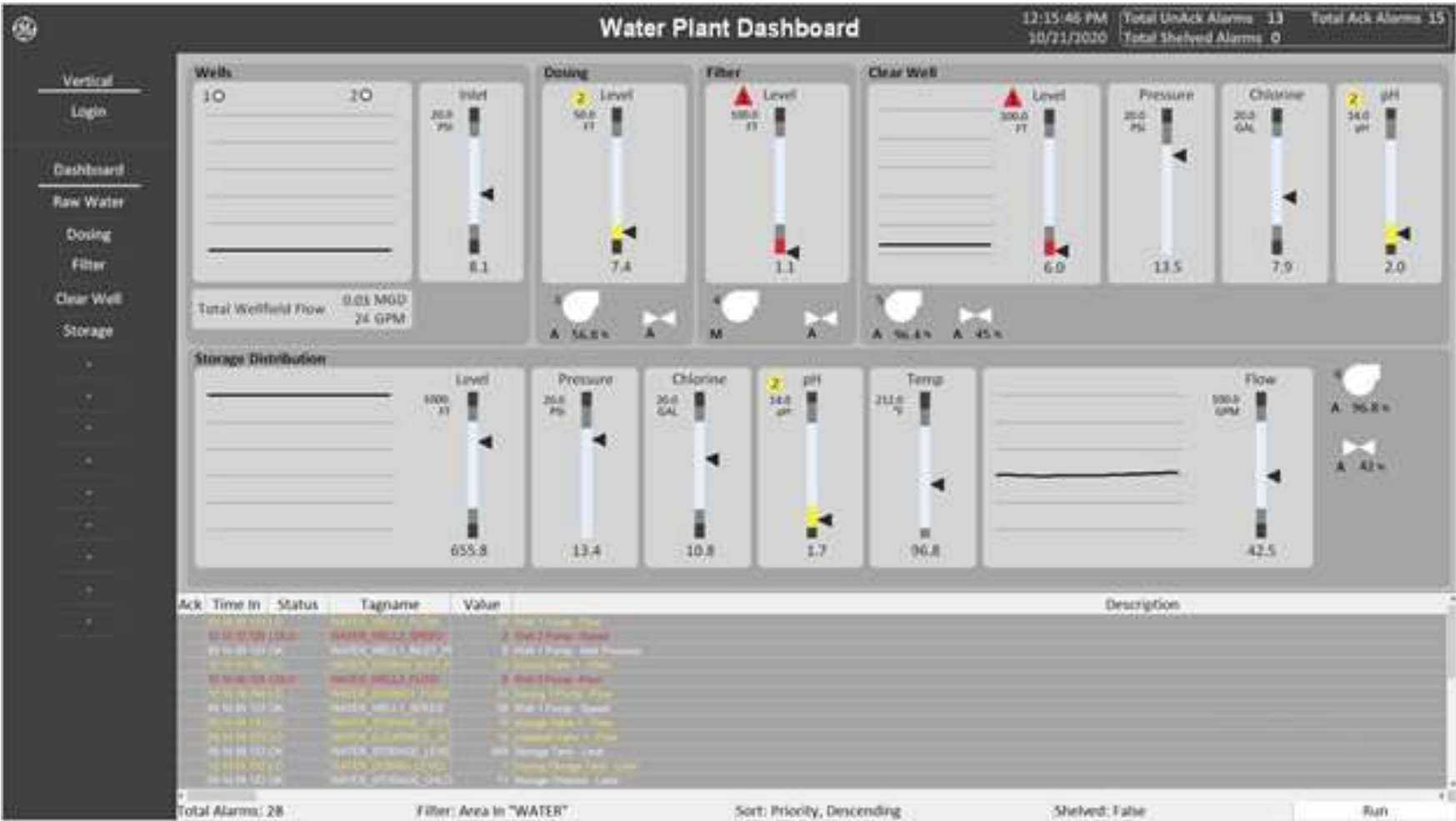
- Create consistent symbols and faceplates for common equipment
- Use parameterized or linked objects where the project architecture supports them
- Keep status, commands and feedback consistent across instances
- Maintain a controlled graphic library and versioned changes
- Validate behavior and security for each reused object type

- Dynamos vs. Dynamo Objects
 - **Master Dynamo:** The original graphical object stored in a Dynamo Toolbar (.tlb file)
 - **Dynamo Instance:** The copy of the Dynamo dropped onto a specific picture screen
- Use Tag Groups (.TGE)
- Global Color Sets



High Performance Graphics in iFIX

Water Plant Sample System



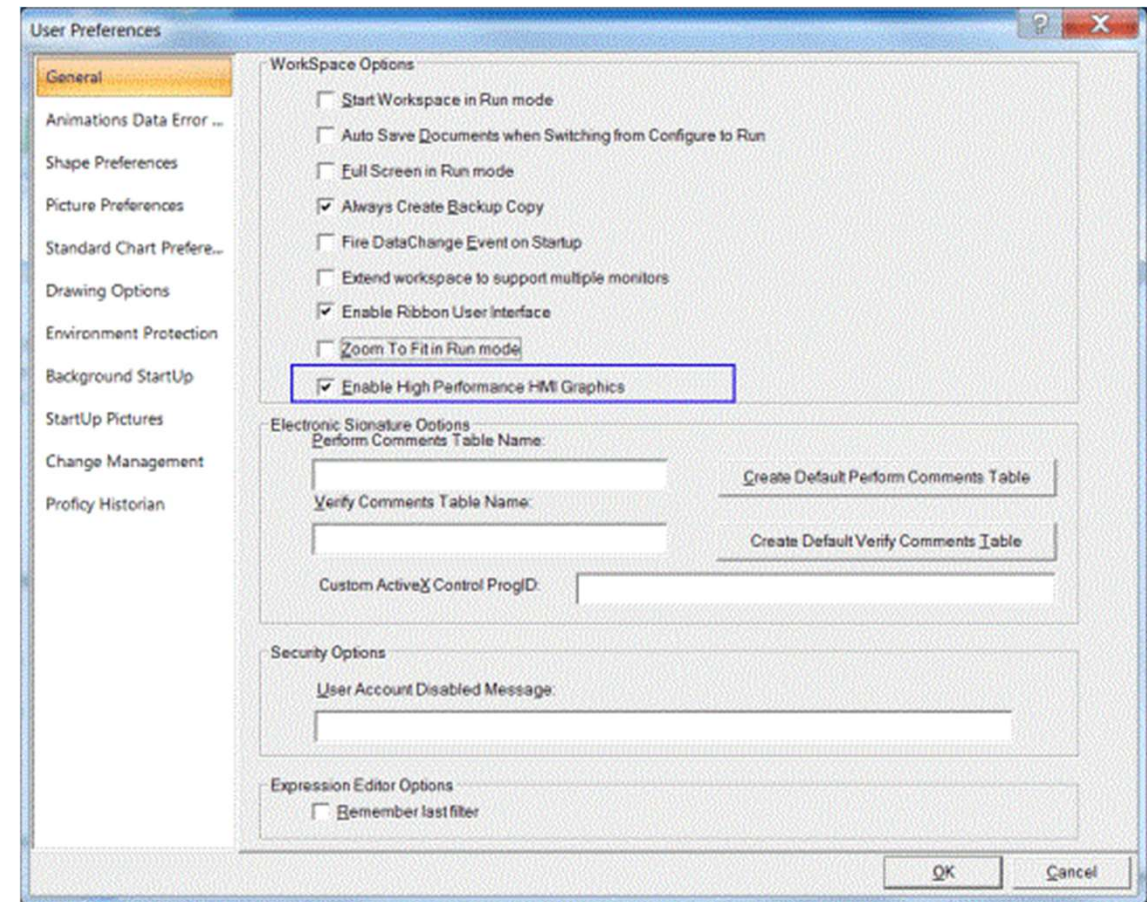
What makes it High Performance?



High Performance Graphics in iFIX

The User Preferences - General Tab dialog box provides a check box to enable or disable high performance HMI graphics.

- High performance color box
- High performance shape foreground colors



ISA-18.2: alarms need a response

- An alarm notifies the operator of an abnormal condition that requires a timely response
- An event records a state change but does not necessarily require operator action
- Define alarm priorities by consequence and response time
- Document the cause, consequence and operator action
- Graphics should present alarms consistently with the site alarm philosophy

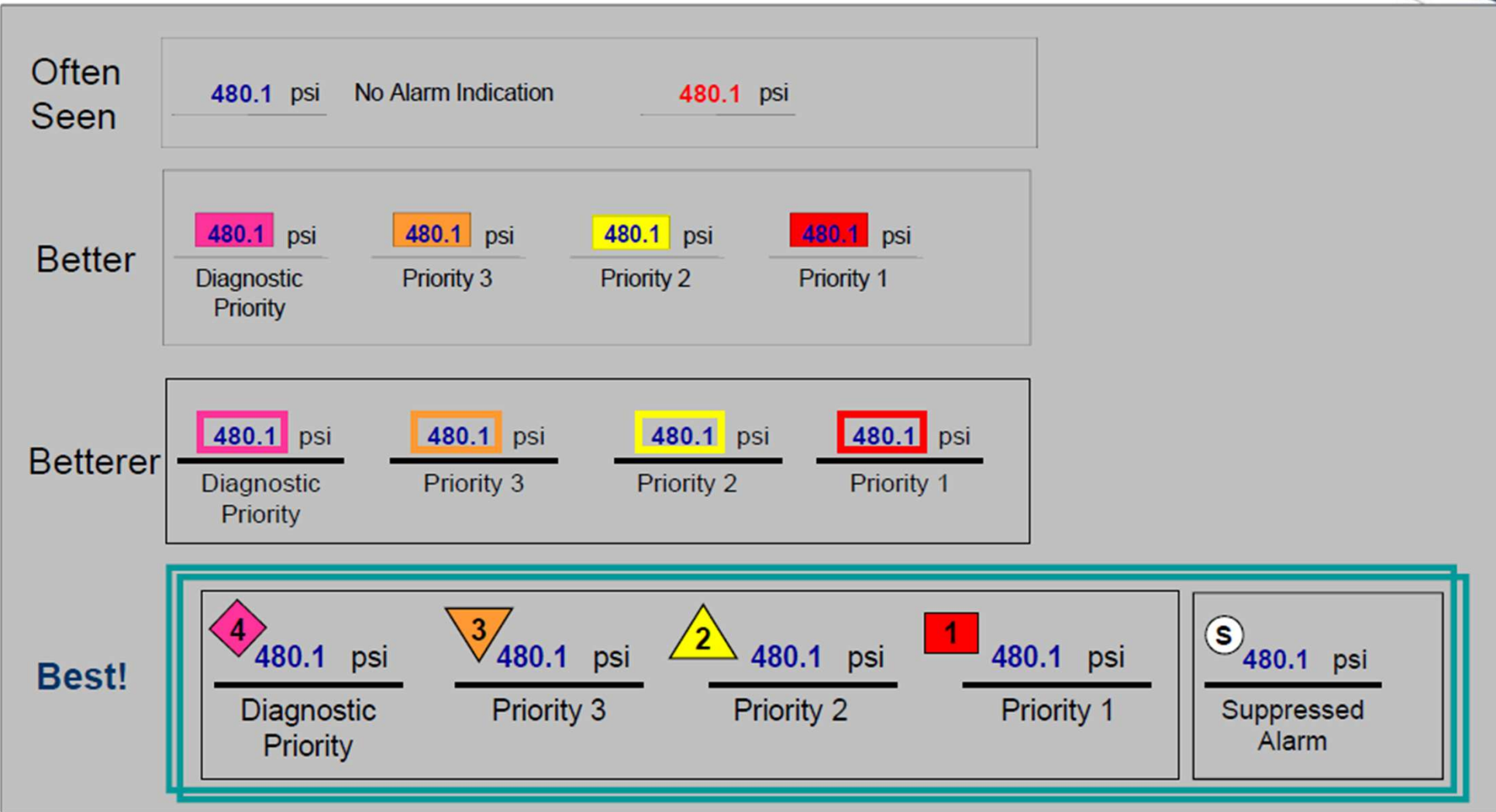


Alarm indications

- Use consistent color, shape and text to identify alarm state and priority
 - Show the affected value and equipment in context
 - Provide access to alarm cause, consequence and recommended action
 - Distinguish alarm state from equipment state and operator selection
 - Suppress or shelve only through governed procedures and authorized roles
- Review nuisance, chattering and standing alarms
 - Use appropriate deadbands, delays, logic and alarm rationalization
 - Apply shelving and suppression under controlled rules
 - Avoid using a process graphic to conceal alarm-system problems
 - Measure alarm performance and review it with operators



Alarm indications



Water and wastewater situation ... an example

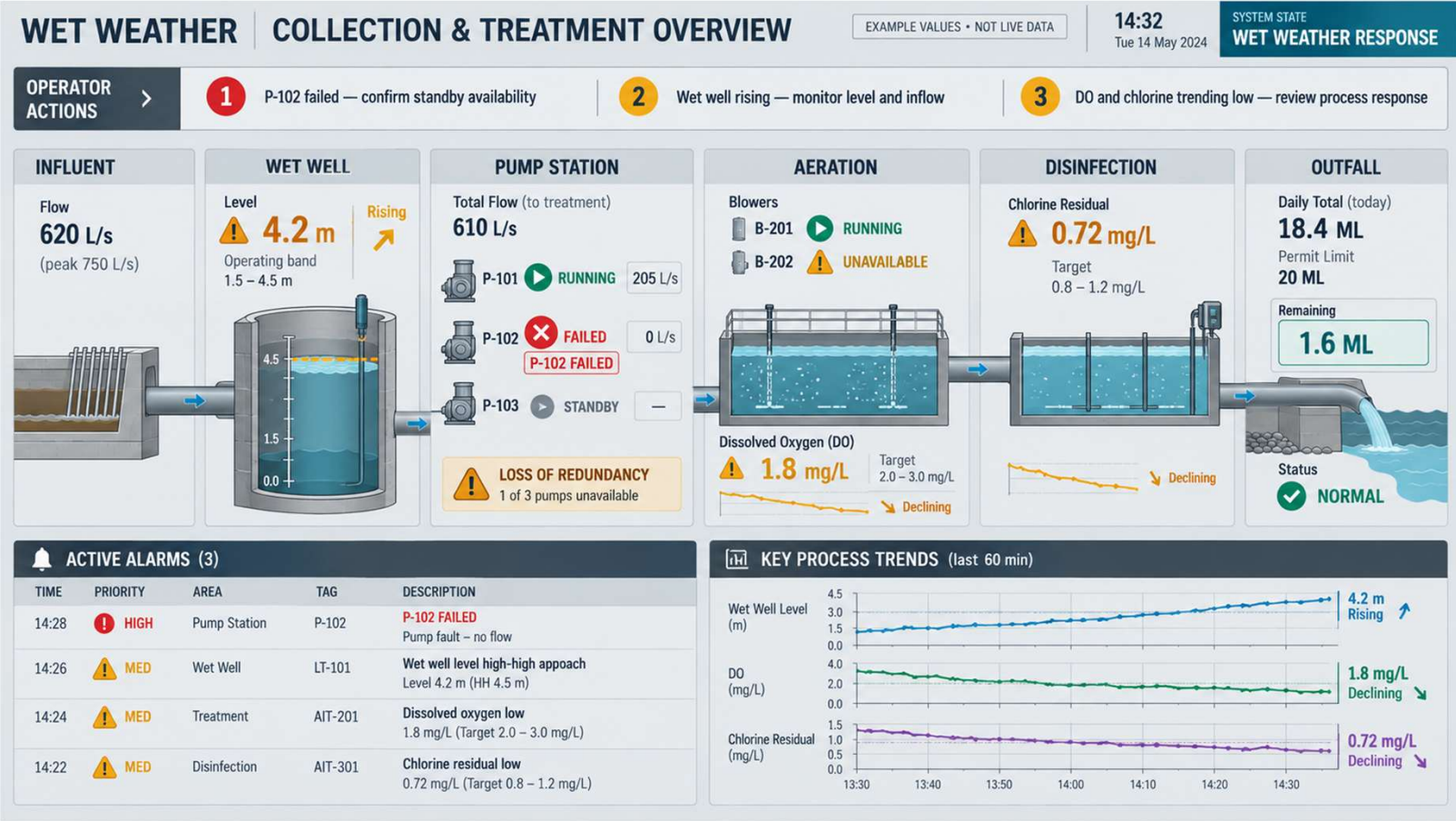
Wet-weather flow and storage capacity

High wet-well level, pump failure or loss of redundancy

Disinfection residual trending toward an operating limit

Blower or aeration capacity loss and declining dissolved oxygen

Outfall permit conditions, daily totals and process stability



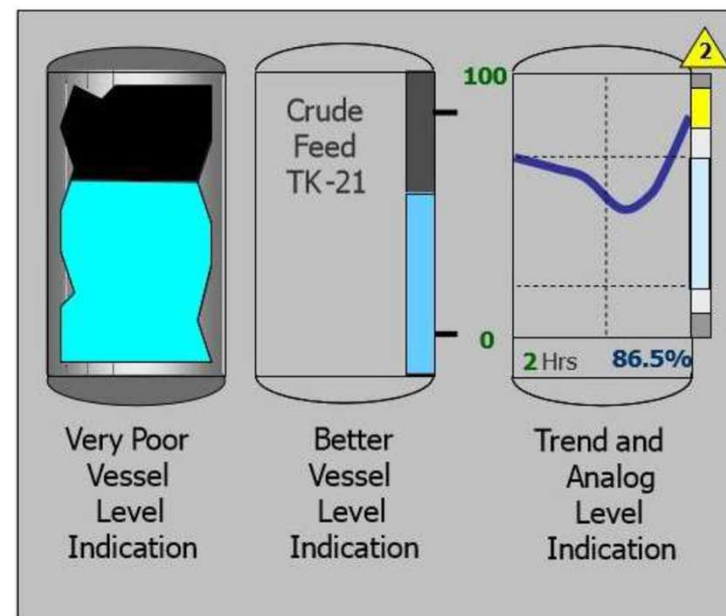


Wet-weather wastewater – A Good Graphic?

Good Elements

- Level 1 shows rainfall context, plant loading, storage capacity and affected sites
- The alarm links to cause, consequence, action and the related operating procedure
- Operators can see what is changing before they decide whether to dispatch field staff

Improvements?



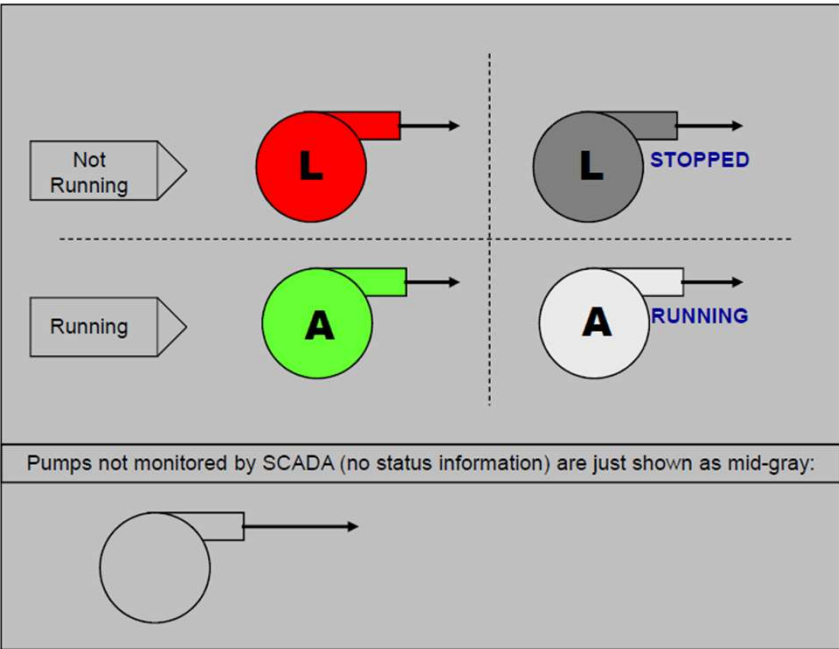


Wet-weather wastewater – A Good Graphic?

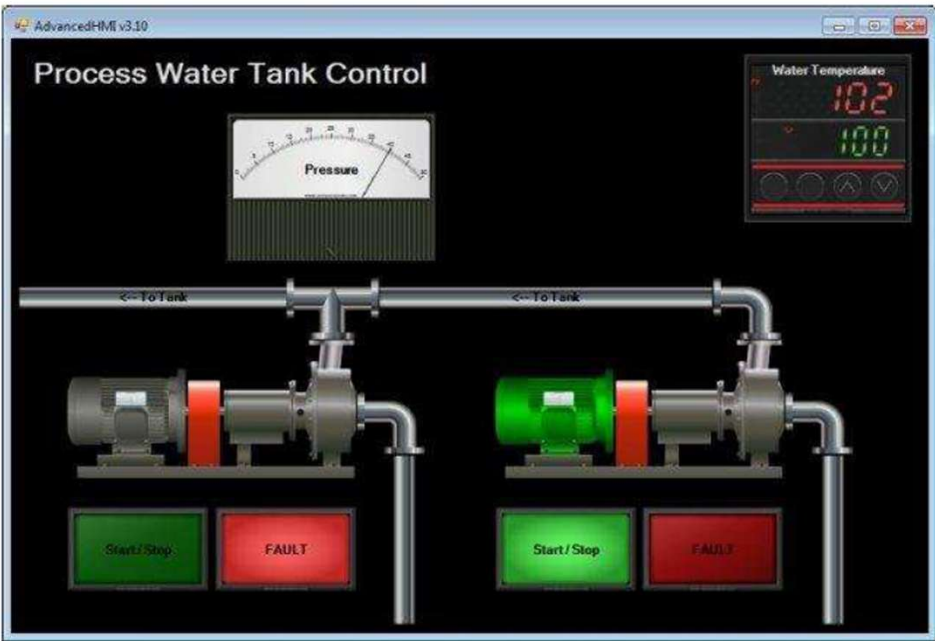
Status Depictions

Red/Green for status OR

Greyscale & redundant coding



and Don't Do This...



Quick exercise: redesign one screen

- Choose a screen from your own operation scenario
- Identify the operator task and the span of control
- Name the information that must be visible at a glance
- Mark what deserves color or alarm emphasis
- Move details and diagnostics to the right display level
- Report one change that would make the screen easier to operate

TASK

AT A GLANCE

EMPHASIS

DETAIL

TEST



Putting the approach into an iFIX project

Actions

- Inventory displays and identify high-use or high-consequence screens
- Talk with operators and document representative tasks
- Set the philosophy, style guide and reusable toolkit
- Prototype, test and revise with operators before broad rollout
- Train users and maintain the design through management of change

Outcomes

- Operators find key status and detail screens with fewer steps
- Displays show operating ranges and trends where decisions require them
- Alarm indications match the site philosophy and remain distinguishable
- Operators can explain the process condition and likely next action
- Track alarm-system measures separately from HMI usability measures

Questions and discussion

- Which display causes the most operator searching today?
- Where does alarm information lose process context?
- Which area would benefit most from a small, operator-tested redesign?

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<https://www.isa.org/standards-and-publications/isa-standards/isa-standards-committees/isa101>

<https://www.isa.org/standards-and-publications/isa-standards/isa-standards-committees/isa18>

Certain pictures and elements used are from the High Performance HMI Handbook

The High Performance HMI Handbook: A Comprehensive Guide to Designing, Implementing and Maintaining Effective HMIs for Industrial Plant Operations

by Bill R. Hollifield, Dana Oliver, Ian Nimmo, and Eddie Habibi

published in 2008 by Plant Automation Services