HFC FORUM - SENSEMAKING, TRUST AND SITUATIONAL AWARENESS IN AUTOMATED SYSTEMS IN NORWAY - HALDEN

Ian Nimmo
President & CEO
UCDS Inc.
www.mycontrolroom.com

HIGH-PERFORMANCE INITIATIVE

- ## What is High-Performance?
    - Well organized displays conveying the context of the system in both a graphical and numeric format.

  How is it measured – what KPI's are available?

  What is the expected return on investment (ROI)?

TRADITIONAL CONSOLE LAYOUT

HIGH-PERFORMANCE INITIATIVE

Box 1 – Milford Haven Explosion 1994
Contributing Factors [Ref 1]

- A control valve was shut when the system indicated it was open
- Maintenance of plant and instrumentation was inadequate
- A modification was performed without appropriate assessment of its consequences
- Control panel graphics did not provide necessary process overviews
- Attempts were made to keep the unit operating when it should have been shut down
- Excessive number of alarms in emergency situation
- Concurrent production and construction activities (SIMOPs)

HIGH-PERFORMANCE INITIATIVE

- A paradigm change has taken place
- 20 years of recognizing the lack of focus on Performance and Situation Awareness, and how to change course:

  - Research and analysis into accidents and production interruptions
  - Interaction with a variety of industries, agencies, and experts
  - Information from academia
  - Advances in technology and new capabilities

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"I thought I felt a paradigm shift, but it was just my undershorts riding up."

HIGH-PERFORMANCE INITIATIVE

- International & industry standards

  EEMUA 191: Alarm Systems – A Guide to Design, Management and Procurement

  EEMUA 201: Process Plant Control Desks Utilizing Human-Computer Interfaces – A Guide to Design, Operational and Human Interface Issues

  > Publication 201 was developed as a result of issues identified during the research for EEMUA 191

  IEC 62692 & ISA 18.02: Alarm Management

  ISA SP101: Human Machine Interfaces

  ISO 11064: Ergonomics of Control Centers

HIGH-PERFORMANCE INITIATIVE

- High-Performance Control Room
  - Focuses on Situation Awareness and Performance Optimization
  - Encompasses all Operator interface points
    - Alarm System
    - Control Room Layout
    - Control Room Lighting & Audio
    - Operator Console
    - Operator Graphical Display (HP-HMI)
  - Rooted in Alarm Management
  - Drives Benchmarks and Objectives
  - Incorporates Human Factors & Ergonomics
  - Reintroduces Proactive Operations
  - Establishes Lifecycle Models

HIGH-PERFORMANCE INITIATIVE

- Standard Definitions
  - HMI High Performance means reduction in Human Error by known standards of accuracy, completeness, and speed.
  - Resulting in reduction in accidents, incidents, and near misses (Abnormal Situations cost the US $20B/Year).
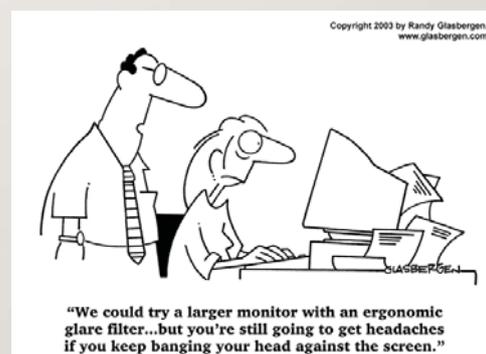 - Increased operator efficiency/performance and reduced training.
  - Focuses on:
    - Detecting
    - Diagnose
    - Recovery

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"We could try a larger monitor with an ergonomic glare filter...but you're still going to get headaches if you keep banging your head against the screen."

HIGH-PERFORMANCE INITIATIVE

- What will be the result?

  - Shift team members who have direct and immediate access to accurate, pertinent information and have an advantage when troubleshooting and controlling abnormal situations.

  - Providing operations personnel with a plant work environment that minimizes stress and supports high performance. This practice provides the plant with a physical work environment that allows operators and support personnel to meet production and operational demands.

"The bad news is, you do less work than anyone in this office. The good news is, you make the fewest mistakes."

HIGH-PERFORMANCE INITIATIVE

- Impacts on Operator & System Performance

  - Application of vision science improves Operator performance

  - Attention to alerts is quicker and more reliable

    - Maximized color properties that draw attention
    - Eliminated distracting colors & elements

  - Identification of elements is less error-prone and easy to communicate

    - Basic nameable colors utilized
    - Sufficient color difference assured

  - Segregation of display regions is reliable without distraction

    - Ensure sufficient discriminability
    - Reduce attention-drawing properties

  - Visibility and legibility assured, prevents errors due to glare and color deficient limitations (color blindness)

HIGH-PERFORMANCE INITIATIVE

- Performance Improvements

Task	With "Traditional" HMI	With High Performance HMI	Improvement
Detecting Abnormal Situations Before Alarms Occur	10% of the time	48% of the time	A 5X increase
Success Rate in Handling Abnormal Situation	70%	96%	37% over base case
Time to Complete Abnormal Situation Tasks	18.1 min	10.6 min	41% reduction

ISA 101.01 – DISPLAY HIERARCHY FOR DECISION MAKING

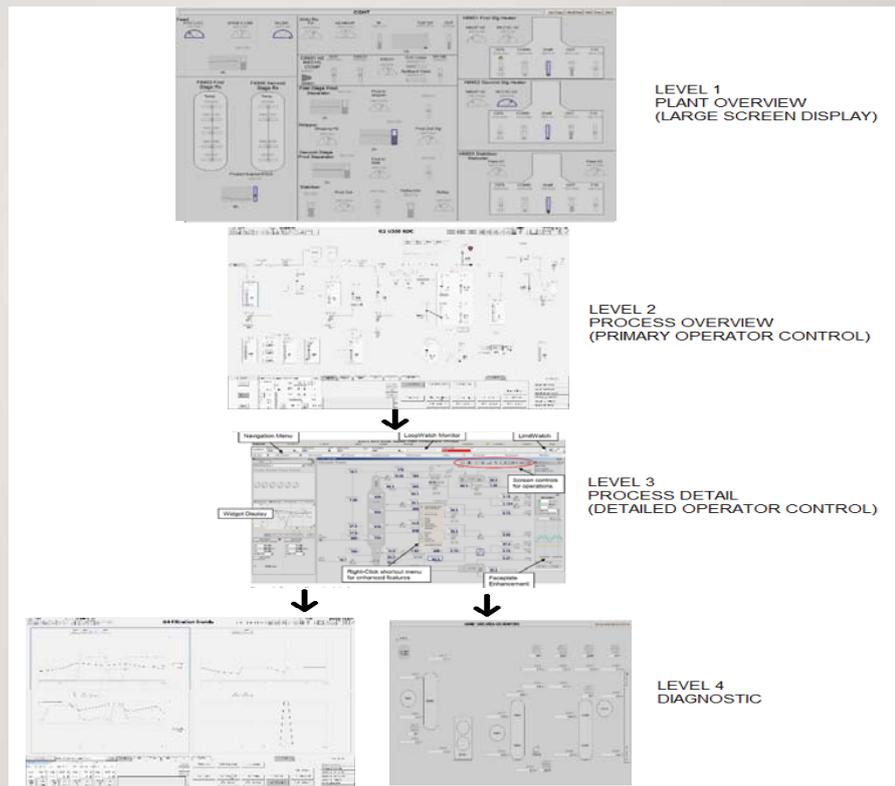| Level 1 – **Situation Awareness** Overview	• Single Operator span of responsibility • In 4 seconds, know "Is my domain OK?" • Key Performance Indicators, Identify that a decision is needed.
Level 2 – **Primary Operating Display** for a subsystem	• Perform tasks for business goals with minimum navigation. • 80 % of everything an operator needs to do on a daily basis. • Focus is on the control actions for the product being shipped.
Level 3 – **Subsystem Details** for major components of the plant	• Subsystem diagnostic and non-routine tasks • Why is this equipment not doing what is expected? Troubleshooting. • Focus is on the equipment being used to make the product
Level 4 – **Task Procedures and Diagnostics**	• Procedure, Help, Interlock information, faceplates. • Interactions between control loops

HIGH-PERFORMANCE – OPERATOR DISPLAY

Organization

LEVEL 1
PLANT OVERVIEW
(LARGE SCREEN DISPLAY)

LEVEL 2
PROCESS OVERVIEW
(PRIMARY OPERATOR CONTROL)

LEVEL 3
PROCESS DETAIL
(DETAILED OPERATOR CONTROL)

LEVEL 4
DIAGNOSTIC

HIGH-PERFORMANCE – OPERATOR DISPLAY

Organization

- **Level 1:** Plant/Process Area Overview
    - Priority 1 Alarms (alarm groups)
    - Key Performance Indicators
    - No navigation, No control
    - Large Screen Display
- **Level 2:** Process Area/Sub-System Overview & Control
    - Priority 1 & 2 Alarms
    - Navigation to Level 2 & 3 Displays
    - Routine/Run-time Control
- **Level 3:** Area/System Detail & Control
    - All Alarms
    - Navigation to Level 2 & 3
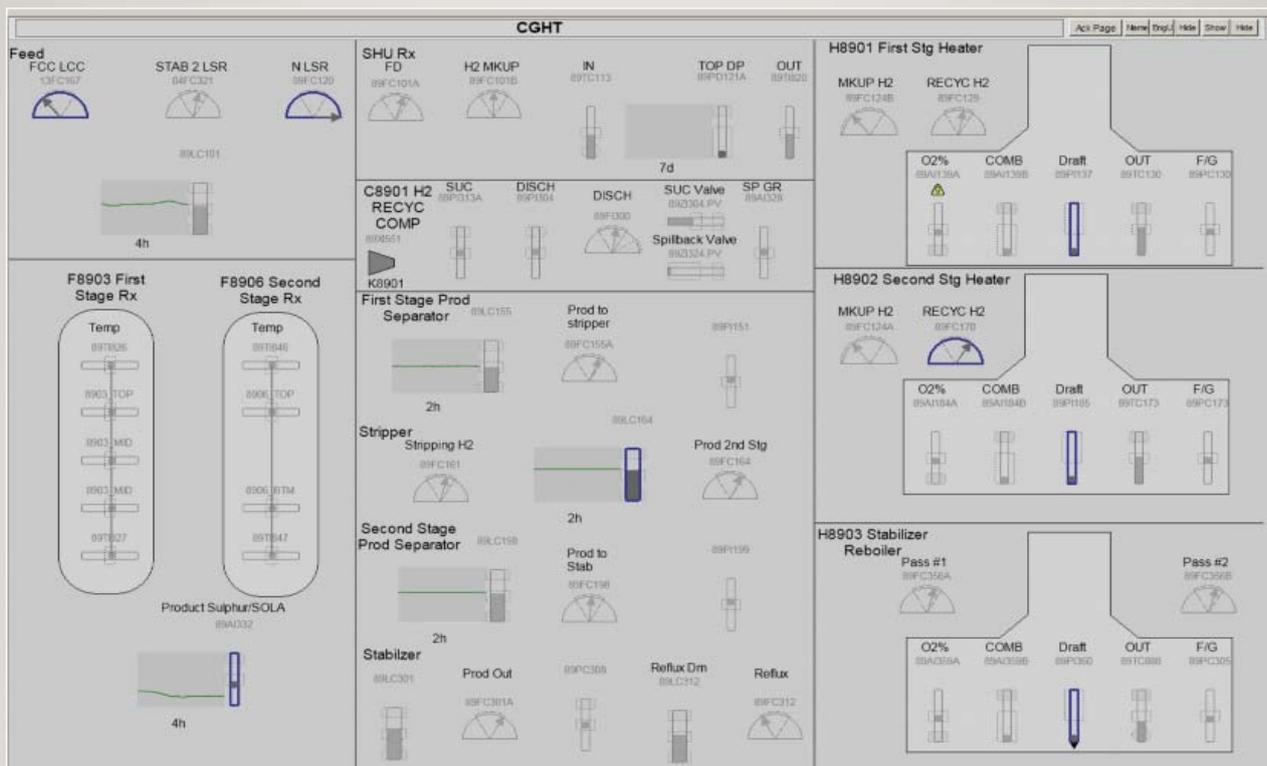   - All Control: Start-up, Shut-down
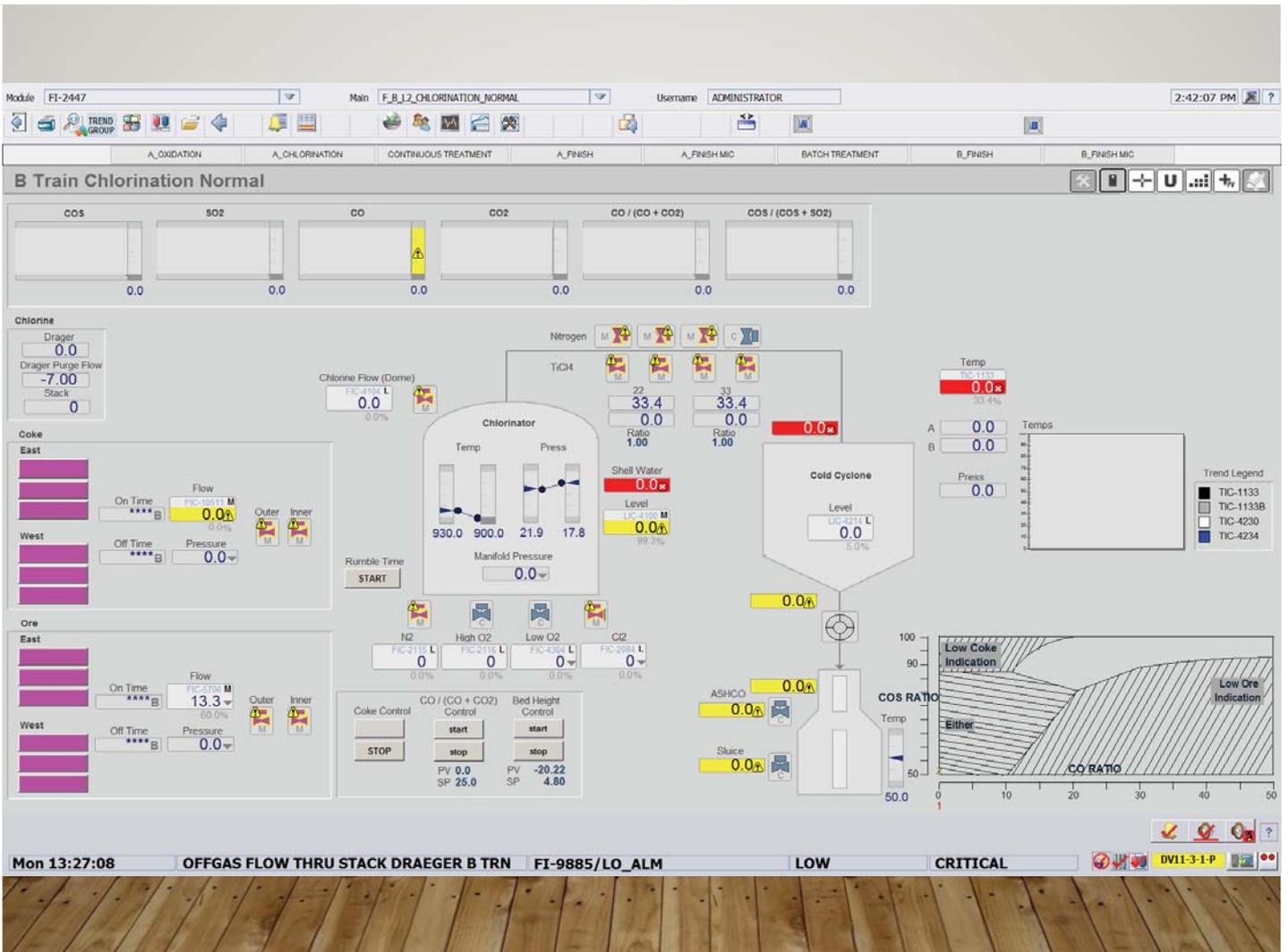- **Level 4:** Area/System Support & Diagnostics

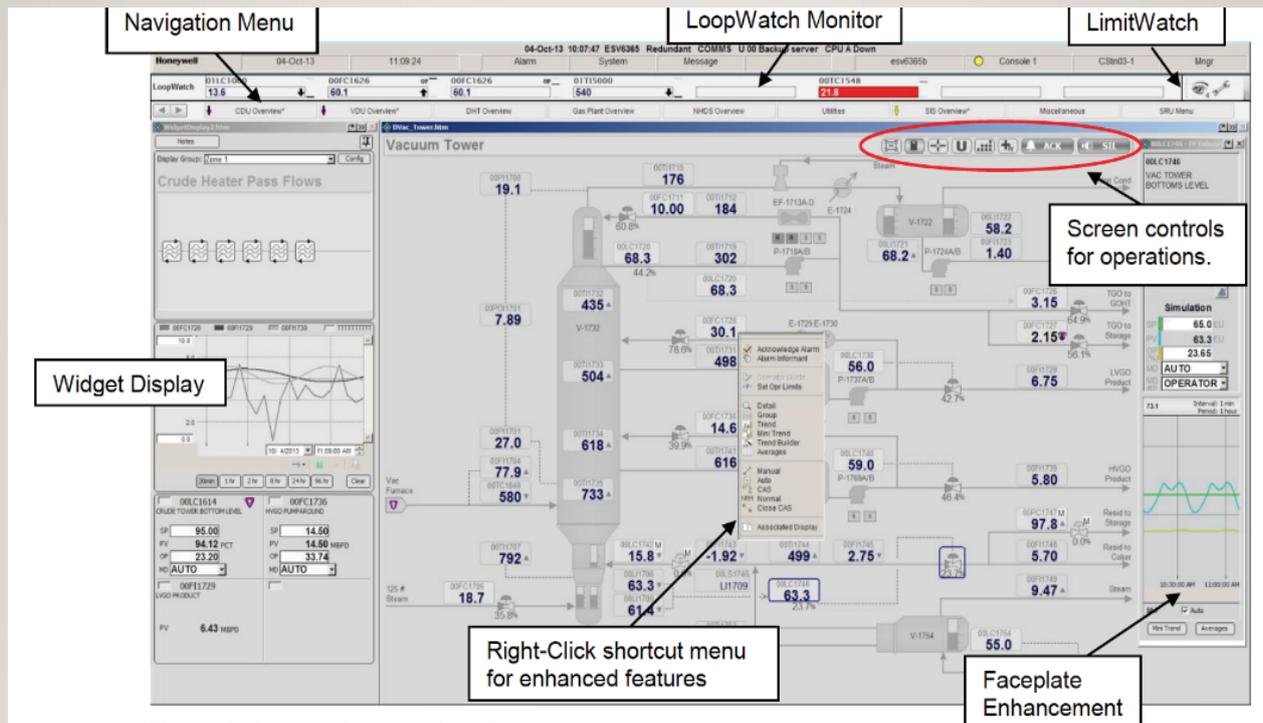# HIGH-PERFORMANCE – OPERATOR DISPLAY

Operator Display Lifecycle

CONTINUOUS WORK PROCESSES

MOC   Audit   Validation

ENTRY

New System Major Changes

ENTRY

New Display Display Changes

Continuous Improvement

SYSTEM STANDARDS

Philosophy

Style Guide

Toolkits

Continuous Improvement

DESIGN

User, Task, Functional Requirements

Console Design

HMI System Design

Display Design

REVIEW

IMPLEMENT

Build Displays

Build Console

Test

Train

Commission

Qualification

OPERATE

In Service

Maintain

Decommission

HIGH-PERFORMANCE – OPERATOR DISPLAY

HIGH-PERFORMANCE – OPERATOR DISPLAY

Navigation Menu

LoopWatch Monitor

LimitWatch

Screen controls for operations.

Widget Display

Right-Click shortcut menu for enhanced features

Faceplate Enhancement

HIGH-PERFORMANCE – OPERATOR DISPLAY

- Operator Display Graphics

  - The Operator Display is one part of the total Operator interface:

    - Provides the Operator with a view of the process or system under control.

    - **C**ritical **A**ction and **D**ecision **E**valuation **T**echnique (CADET)

    - The required number of display screens is a function of the graphical display design, systems requirements and the Operator's workload.

HIGH-PERFORMANCE – OPERATOR DISPLAY

- History of poor application:

  - Color used as a coding system without consideration of impact and following sound HF rules.

  - Color combinations used that are incompatible with many operators (Red – Green), (Blue on Black Background).

  - Text used with inappropriate fonts and text size.
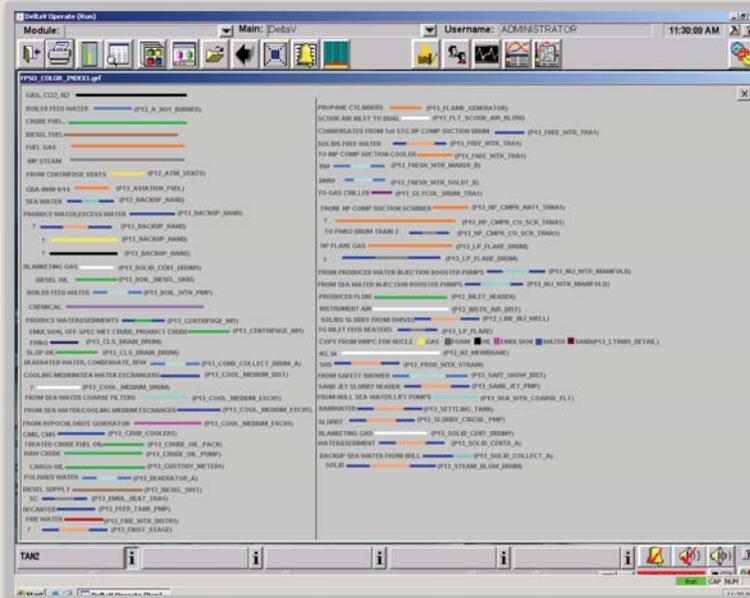
  - Clarity was neglected and lost.

  - Readability was diminished and reduced.

  - Mistakes have resulted in Major Accidents.

HIGH-PERFORMANCE – OPERATOR DISPLAY

- History of poor line color

  - Color should not be used in an attempt to indicate the type of material as it cannot be consistently achieved or memorized by the Operator and proves to be a distraction

HIGH-PERFORMANCE – OPERATOR DISPLAY

- History of poor color application

  - Poor use of blue text on black backgrounds

    - NASA states that as people age their eye develops a yellowing effect which filters low frequency range colors like blue

HIGH-PERFORMANCE – OPERATOR DISPLAY

- History of poor color application
  - ## Poor legibility with color choices
    - Blue should not be used as the foreground color if resolution of fine detail is required
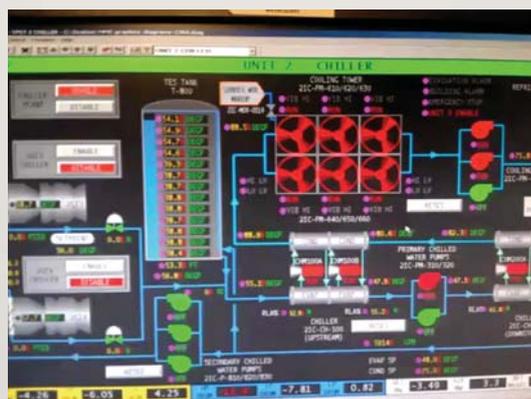   - Blue/Black combinations are difficult to read

HIGH-PERFORMANCE – OPERATOR DISPLAY
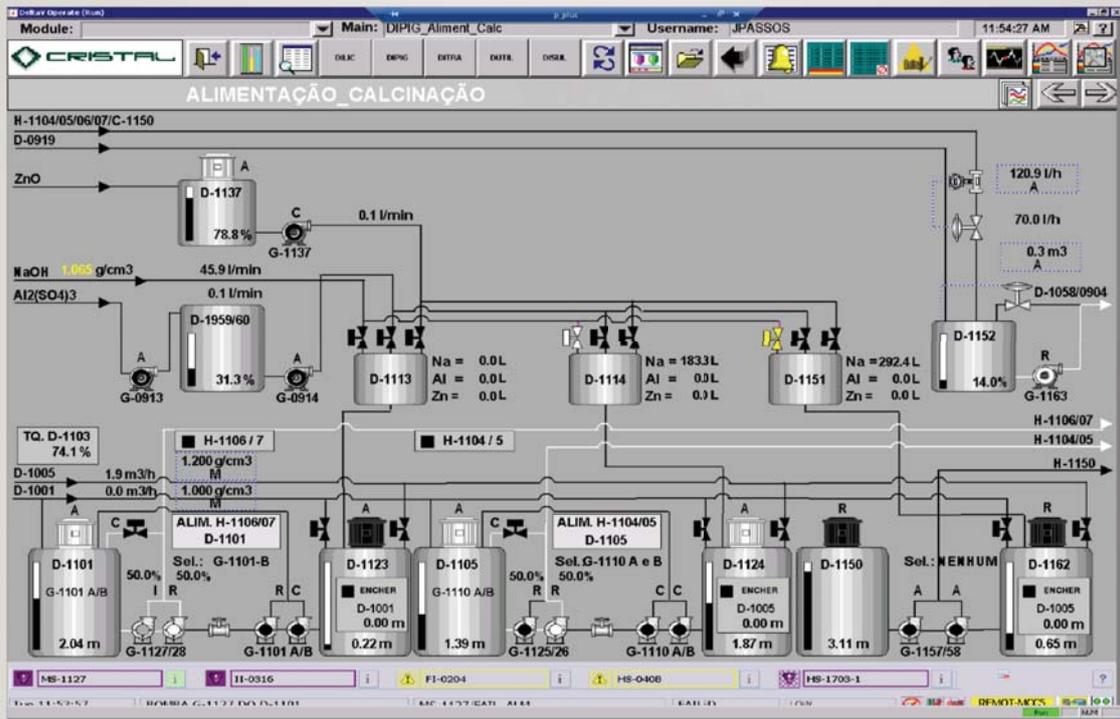
- History of poor blinking & flashing
  - Animation is often added as 'enhancements' to the graphic
    - Animation draws the Operators attention, often irrelevant
    - Animation can lead to Attention Tunneling and adds an unnecessary level of complexity and confusion
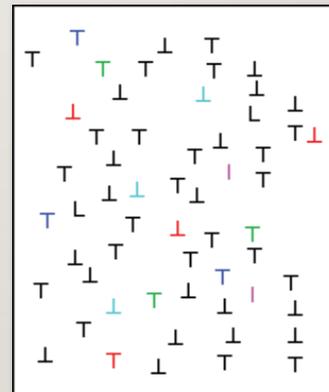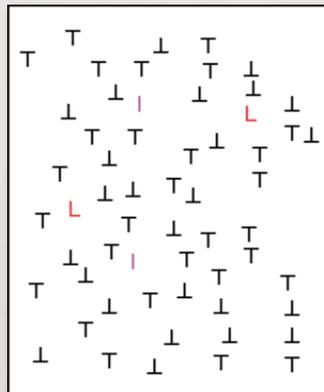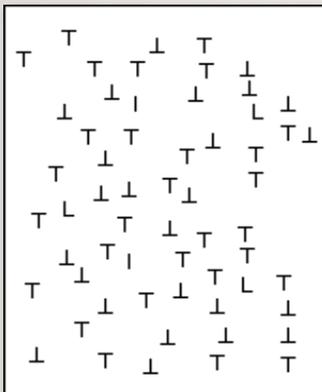
BUT WE HAVE GONE TO GRAY!

HIGH-PERFORMANCE – OPERATOR DISPLAY

- History of poor color coding
  - How many I's & L's
    - The red and magenta coding in the middle make the 'I's and 'L's stand out instantly, without having to inspect each symbol
    - The 'I's on the right are the same color, but the addition of more hue coded subsets makes them harder to locate

HIGH-PERFORMANCE – OPERATOR DISPLAY

- Design Paradigm

    - High-Performance graphics invest in design to minimize burden on Operators at run-time

        - Convert data into information
        - Capitalize on visual processing and pattern recognition
        - Support control of attention to alarms and abnormal indications
        - Enable 'walk-the-board' awareness

    - Imbed intelligence into the graphics
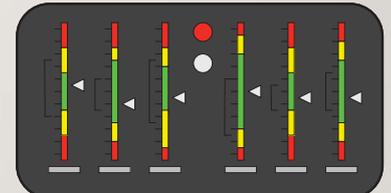
        - Leverage Engineering models and Operator heuristics
        - Discover and show key relationships

    - Optimize graphics for human performance

        - Maximize usefulness
        - Maximize usability

HIGH-PERFORMANCE – OPERATOR DISPLAY

- Design Paradigm

    - High-Performance graphics

        - Process lines are shown as Gray with line width and type to differentiate different process types

        - Process lines minimize crossings and elbows

        - Process line elbows are rounded to soften the overall appearance

        - Arrows on process lines are minimized, used only where required, and relocated to be near equipment and vessels

        - Units of measure and Instrument Tags are shown in low contrast text if at all

HIGH-PERFORMANCE – OPERATOR DISPLAY

- Performance Requirements
  - Clarity
    - Graphics, text, and numeric displays should be clear, easy to read, and it should be obvious to what they refer to
    - Cool and subdued colors should be used in normal operation to allow bright colors to stand out in abnormal situations
    - Graphics do not contain unnecessary detail and clutter
    - Graphics convey relevant information, not just data
    - Alarms and indications of abnormal situations are clear, prominent, and consistently distinguishable

HIGH-PERFORMANCE – OPERATOR DISPLAY

- Performance Requirements
  - Consistency
    - All graphic indicators, text, and color coding should be consistent, not only within a display format, but between display formats in the hierarchy
    - A good design framework specifies consistent display location for common objects such as titles, navigation aids, object labels
    - Information should be arranged in displays to support simultaneous viewing and interaction requirements that are needed for critical monitoring and control tasks
    - The Operator Display is set up for navigation in a logical, hierarchical, and performance-oriented manner

HIGH-PERFORMANCE – OPERATOR DISPLAY

- Design Graphic Style
  - Navigation Techniques
    - Multiple navigation methods are provided to facilitate quick, direct access to primary displays and minimal keystrokes to secondary and associated displays
      - Main Menu
      - Top button bar – Level 2 & 3 displays
      - Paging – up, down, left, right
      - Recall and Forward
      - Page Connectors
      - Right-click
    - Navigation to primary Level 2 displays should be accessible in 1 key strokes
    - Navigation to secondary Level 3 displays should be accessible in 2 key strokes or less
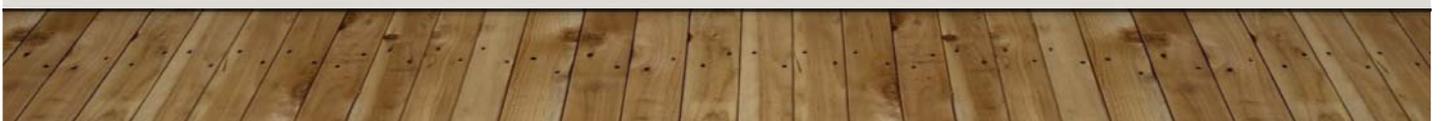

HIGH – PERFORMANCE RESULTS

- Easy to find the information

- Less cognitive workload

- Simple prioritization of tasks

- Good Situation Awareness (Past – Present – Future)

- Avoid (Mica's Demons) that compromise SA

- Diagnosis of all Critical and High Priority alarms on just Level 1 & level 2 Displays.

HIGH-PERFORMANCE – CONTROL ROOM

- Operator Console
    - The Operator Console should be designed to incorporate Ergonomic features
        - Proper viewing distance and angles reduce eye, neck, and body strain

HIGH-PERFORMANCE – CONTROL ROOM

High-Performance Control Room

HIGH-PERFORMANCE – CONTROL ROOM

HIGH-PERFORMANCE – CONTROL ROOM

Large Screen Display still work to do!

HIGH-PERFORMANCE – CONTROL ROOM

HP – HMI, HP – Alarms, Control Room Designed to ISO 11064, CRIOP V&V, All Demons Exorcised !

USER CENTERED DESIGN SERVICES, INC.
Achieving Excellence In Operations

JOIN US IN PRESCOTT, ARIZONA FOR THE 2018 CONTROL ROOM WORKSHOP

COME AND FIND OUT AS YOUR CONTROL ROOM EXPERTS, USER CENTERED DESIGN SERVICES, CONDUCTS A FIVE-DAY WORKSHOP AT THE HISTORIC HASSAYAMPA HOTEL IN BEAUTIFUL PRESCOTT, ARIZONA, JUNE 17 – 22, 2018. LEARN ABOUT BEST PRACTICES IN CONTROL ROOM ERGONOMICS, OPERATIONS EXCELLENCE TOPICS SUCH AS HIGH-PERFORMANCE GRAPHICS, ALARM MANAGEMENT AND PROPER STAFFING.

SESSIONS (OVER FOR DETAILS) WILL BE LED BY IAN NIMMO, PRESIDENT AND FOUNDER OF USER CENTERED DESIGN SERVICES, AND HIS STAFF OF INDUSTRY PROFESSIONALS. MR. NIMMO IS A FOUNDER AND FORMER PROGRAM DIRECTOR OF THE ABNORMAL SITUATION MANAGEMENT (ASM) CONSORTIUM. IN THAT ROLE MR. NIMMO SAW A NEED IN THE INDUSTRIAL MARKETPLACE FOR OVERALL CONTROL ROOM AND HUMAN FACTORS EXPERTISE. TO FILL THE VOID, HE LEFT AND FOUNDED USER CENTERED DESIGN SERVICES, INC. IN 2000.

THE WORKSHOP WILL BEGIN SUNDAY EVENING WITH A WELCOME RECEPTION SPONSORED BY OUR PARTNER, LIN & ASSOCIATES.
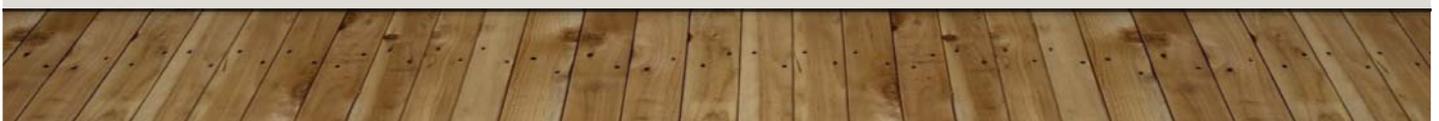
ALSO INCLUDED IN YOUR FEE IS A MID-WEEK BREAK TO ENJOY THE GRANDEUR OF THE GRAND CANYON.

HOTEL RESERVATIONS SHOULD BE MADE WITH THE HASSAYAMPA INN (1.800.322.1927) – WWW.HASSAYAMPAINN.COM

DATE: JUNE 17-22, 2018
WORKSHOP WILL FEATURE INDUSTRY EXPERT AND UCDS PRESIDENT &

PRICING: $585 INDIVIDUAL

FOUNDER IAN NIMMO

SITUATION AWARENESS
ABNORMAL SITUATION AWARENESS ENCOMPASSES A RANGE OF EVENTS OUTSIDE THE "NORMAL" PLANT OPERATING MODES, E.G. TRIPS, FIRES, EXPLOSIONS, TOXIC RELEASES, OR SIMPLY NOT REACHING PLANNED TARGETS. THE SITUATION AWARENESS WORKSHOP FOCUSES ON IMPROVING SITUATION AWARENESS IN THE CONTROL ROOM, THEREBY IMPROVING OPERATOR PERFORMANCE AND REDUCING OPERATOR WORKLOAD

HIGH PERFORMANCE HMI
PROPER HMI DESIGN CAN REDUCE OPERATOR WORKLOAD, IMPROVE SITUATIONAL AWARENESS, AND AID THE OPERATOR IN PREVENTING MINOR DEVIATIONS FROM BECOMING MAJOR INCIDENTS. WELL-DESIGNED HMI ALSO WORKS HAND-IN-HAND WITH ALARM MANAGEMENT INITIATIVES. BETTER PRESENTATION OF INFORMATION TO THE OPERATOR IMPROVES OVERALL SITUATION AWARENESS

HMI EXPERIENCE
LIN & ASSOCIATES AND UCDS HAVE EXTENSIVE PARTNERSHIP EXPERTISE IN FOLLOWING HMI STANDARDS, REGULATIONS, AND BEST PRACTICES. THIS SEGMENT WILL PRESENT EXAMPLES AND ILLUSTRATIONS OF OUR PAST PROJECTS

CONTROL ROOM DESIGN
UCDS HAS PARTICIPATED IN OVER 200 CONTROL ROOM DESIGNS AND REDESIGN PROJECTS ACROSS MULTIPLE INDUSTRY SECTORS AROUND THE WORLD. OUR METHODOLOGY IS GROUNDED ON THE INTERNATIONAL STANDARD (ISO) 11064 WHICH ENSURES THAT ALL IMPORTANT ASPECTS OF THE OPERATION OF A MODERN CONTROL ROOM ARE CONSIDERED. TOPICS FOR THIS SESSION WILL INCLUDE: WHY YOU REALLY NEED TO UNDERSTAND THE ISO 11064 STANDARD, HOW TO DESIGN A CONTROL ROOM, CONTROL ROOM ERGONOMICS, HVAC, LIGHTING, ACOUSTICS, NOISE CONTROL, AND TRAFFIC FLOW.

STAFFING STUDIES
STAFFING LEVELS IN MANY FACILITIES ARE DETERMINED THROUGH THE PROCESS OF LABOR FORCE NEGOTIATIONS. UCDS UTILIZES A UNIQUE METHODOLOGY SPECIFICALLY ADDRESSING THE DIFFERENCES BETWEEN TYPES OF OPERATIONS AND FACILITIES. FOR A TYPICAL OIL REFINERY STUDY, IT IS NOT UNUSUAL TO IDENTIFY FIELD OPERATOR STAFFING REDUCTIONS OF 10 PERCENT AND CONSOLE OPERATOR REDUCTIONS OF 25 PERCENT. TOPICS FOR THIS SESSION WILL INCLUDE HOW UCDS WILL PROVIDE REALISTIC AND ACHIEVABLE RECOMMENDATIONS FOR DECISION MAKING AND ASSIST IN IMPLEMENTING OUR RECOMMENDATIONS.

MANAGEMENT OF ORGANIZATIONAL CHANGE (MOOC)
JUST LIKE MANAGEMENT OF CHANGE (MOC) WILL ENSURE CHANGES ARE JUSTIFIED, SAFE, AND DOCUMENTED, THE SAME IS NECESSARY WHEN ORGANIZATIONAL CHANGES ARE IMPLEMENTED. MANAGEMENT OF ORGANIZATIONAL CHANGE (MOOC) WILL ENSURE THAT SAFETY IS NOT COMPROMISED DURING ABNORMAL AND EMERGENCY SITUATIONS BEFORE PROPOSED STAFFING CHANGES.

CONTROL ROOM PHILOSOPHY
CONTROL ROOM PHILOSOPHY AS RELATED TO BEST PRACTICES AND CRISIS INTERVENTION AND OPERABILITY (CRIOP). CRIOP IS A METHODOLOGY USED TO VERIFY AND VALIDATE THE ABILITY OF A CONTROL CENTER TO SAFELY AND EFFICIENTLY HANDLE ALL MODES OF OPERATIONS INCLUDING START UP, NORMAL OPERATIONS, MAINTENANCE, PROCESS DISTURBANCES, CRITICAL SITUATIONS AND SHUT DOWN.

CONTROL ROOM SECURITY
UCDS OFFERS A SITE SECURITY ASSESSMENT TO DETECT VULNERABILITIES FOR A VARIETY OF THREATS. THIS SESSION WILL ADDRESS SECURITY LIABILITIES AND COMPLIANCE TO ESTABLISHED STANDARDS. (DHS) PROVIDED GUIDANCE ON HOW TO IDENTIFY, HANDLE AND SAFEGUARD INFORMATION DEVELOPED BY PRIVATE AND PUBLIC ENTITIES UNDER SECTION 550 OF PUBLIC LAW 109-295. THE CHEMICAL FACILITY ANTI-TERRORISM STANDARDS (CFATS), AND 6 CFR PART 27. PURSUANT TO CFATS, THIS INFORMATION IS KNOWN AS CHEMICAL-TERRORISM VULNERABILITY INFORMATION, OR CVI

CONSOLE DESIGN
UCDS OFFERS AN ERGONOMIC CONSOLE SPECIFICATION DOCUMENT BASED ON THE ISO 11064 DESIGN STANDARD WHERE WE IDENTIFY THE USER REQUIREMENTS THROUGH A TASK ANALYSIS STUDY AND USER-CENTERED SPECIFICATIONS. AN ERGONOMIC CONSOLE SELECTION BEGINS WITH A THOROUGH TASK ANALYSIS. TOPICS FOR THIS SESSION WILL INCLUDE THE USER'S ROLES, TASKS, AND NEED FOR A HEALTHY WORKING ENVIRONMENT THAT PROMOTES VIGILANCE AND COMBATS FATIGUE.

FATIGUE
FATIGUE PLAYS A BIG PART IN HUMAN ERROR. TOPICS FOR THIS SESSION WILL INCLUDE THE CONTRIBUTION OF FATIGUE TO HUMAN ERROR AND INCIDENTS, FATIGUE MANAGEMENT, AND THE FATIGUE RISK MANAGEMENT PLAN COVERED BY THE API RP.

SHIFT HANDOVER
SHIFT HANDOVER COMMUNICATIONS HAS BEEN IDENTIFIED AS A FACTOR THAT CONTRIBUTED TO AN AVERAGE OF 20 PERCENT OF THE INCIDENTS IN CONTINUOUS PROCESSING INDUSTRIES. ENSURING UNINTERRUPTED PRODUCTION, SAFETY, AND EFFICIENCY REQUIRES CRITICAL INFORMATION BE ACCURATELY COMMUNICATED AT SHIFT CHANGE. TOPIC FOR THIS SESSION WILL DISCUSS SHIFT HANDOVER BEST PRACTICES.

ALARM MANAGEMENT STANDARDS
A POORLY IMPLEMENTED SYSTEM ADDS TO WORKLOAD, INCREASES FRUSTRATION, STRESS, AND CONFUSION, AND CAN ULTIMATELY IMPACT SAFETY, RELIABILITY, PRODUCTION, AND PROFITABILITY. UCDS PROVIDES A COMPREHENSIVE ARRAY OF ALARM MANAGEMENT SERVICES WHILE UTILIZING BEST PRACTICES AND INDUSTRY STANDARDS THAT CAN BE USED TO EVALUATE YOUR CURRENT PLANT CONDITION AND MAKE REALISTIC AND ACHIEVABLE RECOMMENDATIONS FOR IMPROVEMENT.

OPERATIONS, BEST PRACTICES
AT THE BEGINNING OF THE ASM CONSORTIUM RESEARCH PROGRAM OPERATION BEST PRACTICES WERE DEVELOPED FROM MANY SITE STUDIES AROUND THE WORLD. THESE HAVE BEEN CONTINUOUSLY IMPROVED ON OVER 25 YEARS AND ARE NOW A SIGNIFICA... TTING A VISION AND CORRECTING MANY GAPS IN YOUR MAN...

Welcome reception sponsored by

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