Dal Vernon Reising
Incident Avoidance through Proactive Monitoring
The Abnormal Situation Management® (ASM®) Consortium

Innovating and Fielding ASM® Solution Concepts

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ASM Operator Interface Features

For Proactive Monitoring:

- Integrated Trending

- Integrated alarm management into graphics and navigation tabs

- Multi-level, simultaneous views of increasing plant detail
  - Level 1 Area Overview,
  - Level 2 – Unit Summary
  - Level 3 – Equipment detail
  - Level 4 – Group & Point detail
For Fast Response:

- “Yoked” navigation between display levels
  - e.g., across a Unit summary & its associated equipment detail displays

- Multi-windowing with controlled window management
- Tabbed navigation within a display level
ASM Operator Interface Features

For Fast Response:

- ASM Graphics design
  - e.g., Color-coding only for critical information – like alarms, No 3D graphical objects, etc.
- Right-mouse click access to online documentation
  - e.g., Alarm Objective Analysis documents, procedures, etc.
Operator Interface Case Study

Objective

• Develop a case study to illustrate the potential impact of ASM® Consortium Advanced Operator Interface concepts
  – Hypothesis: the ASM style of operator interface improves operator performance for incident avoidance and in abnormal situations

Approach

• Compare operators performance on their units’ own high-fidelity simulators using:
  – Traditional single window operator interface console versus
  – ASM-structured, multi-window operator interface console
The Side-by-Side Comparison

Traditional Console Simulator

Front View

Equipment Key

| U | A | A | G | U | G | E | L | G |

Plan View

Equipment Key

U - Universal Station
A - Alarm Annunciator Pod
F - Equipment Panel
G - GUS Workstation Monitor

ASM-style Console Simulator

Front View

Equipment Key

G | G | A | A | P | O | P | C
G | G | E | G | G

Plan View

Equipment Key

G - GUS Workstation Monitor
PC - Personal Computer
E - Equipment Pod
A - Alarm Annunciator
Operator Interface Case Study

Traditional, single-window operator displays console

- The console was a mix of US & GUS workstations, with Native window displays
- Displays were classified as a “traditional” design, although these Native displays were of “high quality”, i.e., were compliant with many of the recommended ASM interface guidelines
  - half-intensity lines to depict static process piping
  - navigation points at the beginning and ends of flows onto and off pages
  - a general left to right, top to bottom process arrangement,
  - lower salience for less important static text information
- As a comparison these “traditional” displays represent a “better practice” than the industry norm for operating schematics
  - This fact makes for a conservative comparison in this study’s performance testing
- This unit’s training simulator interface closely matches that of the actual plant
Operator Interface Case Study

ASM-style operator interface console

- GUS workstations using Gus Picture Builder
  - There were two 21” monitors per workstation using Safeview

- Key features
  - Multi-window format with controlled window management
  - Multi-level view
    - Level 1 Area Overview, Level 2 – Unit, Level 3 – Equipment, Level 4 - Group
  - Integrated into the console:
    - Trends, online information, navigational support (yoking and focus)
  - Closely follows recommend ASM interface guidelines

- This unit’s simulator could be better matched to real plant console
  - Makes for a conservative comparison in the performance testing of this study
Case Study Experimental Design

- The case study involved a two-part test for 2 groups of operators
  - **Pre-test** – Establish if there were any differences in operations and plant experience between the 2 groups
  - **Scenario testing** – Establish if there were any performance difference in incident detection, incident prevention between the 2 interfaces
    - Tested the operators on 4 matching scenarios
- **A total of 21 operators:**
  - 10 for Traditional;
  - 11 for ASM-style
Case Study Scenarios

- Used 4 scenarios in the operator performance evaluation
  - Looked for scenarios which had similar development time and matching instrumentation
  - Allowed for better isolation of the effect between the operator interfaces on operator performance for each scenario

- The 4 scenarios were
  - A cracked gas steam turbine vacuum problem
  - A cracked gas compressor suction pressure transmitter drift
  - A cracked gas compressor discharge pressure safety valve (PSV) passing to flare
  - A turbo expander bypass valve drift open
Case Study Results

Pre-Test Results for differences between Operator groups

- No average differences between the two groups of operators for:
  - Number of years experience as an operator
  - Number of years experience as an operator at this company
  - Number of years experience as a console operator
  - Percent of panel rounds correctly identified
Case Study Results

Scenario Results for differences between Interfaces

- Significant difference for **Time to Orient** to the problem
  - Overall, the operators using the ASM-style interface were *more* proactive, orienting to the problem an average of 4 minutes faster

- For the first scenario with the Traditional console, an alarm rang in which oriented them to the problem faster, but...

- They didn’t solve the problem faster! (see Next slide)
Case Study Results

Scenario Results for differences between Interfaces

- Significant difference for **Total Completion Time**
  - The operators using the ASM-style interface took significantly *less time* to deal with the event and as a group, were *more* consistent in doing so!
  - Operators using the ASM-style interfaces completed trials in an average of 10.6 minutes vs. 18.1 minutes for those using the traditional console (41% improvement)
Case Study Results

Scenario Results for differences between Interfaces

• Detecting the event BEFORE the first alarm
  – On average, operators using the ASM-style interface detected an event before the alarm 48% of the time
  – A 38% improvement

• Successful completion of the scenario
  – On average, operators using the ASM-style interface successfully dealt with the situation 96% of the time
  – A 26% improvement

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<td>Mean</td>
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<td><strong>95.5%</strong></td>
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Economic Impact Assessment

- Conducted a Monte Carlo simulation for the Traditional console
  - Used the operator performance improvement values and ranges as input into this simulation
    - Improved solution times
    - Higher solution success rates
  - Generated an annual baseline from 6 years of incident data from the traditional console unit
  - The “assumed” input ranges for the incident data in the Monte-Carlo analysis were supplied by ASM member site’s process experts

VS.
The total economic impact for the unit with the traditional console (a 1.8 Blb/year ethylene plant) was

- On average, $870K USD/year
- The median (considered most likely) was $800K USD/year
Future ASM work on Proactive Monitoring

“Span of Control” Overview Displays

Concept: Operator visually scans for graphical deviations

- Continuously monitors critical variables in context of their limits
- There would be visual indications of the operating envelopes
  - In the equipment graphics, point value indicators, and trends
  - Immediate indication of potential problems
- There would be composite indicators of process and equipment “health”
  - Immediately detect deviation from “healthy” process operation
Future ASM work on Proactive Monitoring

“Span of Control” Overview Displays

Concept: Operator visually scans for graphical deviations

- Deviations would be detected visually, as they evolve over time
Summary Points

• ASM operator interface principles support *Proactive Monitoring* behavior in operators

• This behavior leads to clear performance improvements

• These improvements can be directly translated into economic benefits

• The ASM Consortium continues to work on better interface concepts