Advances in Abnormal Situation Management



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What is the ASM Consortium?



Overview of UI Best Practices



Evaluation of Qualitative Shapes



ASM Consortium What is an Abnormal Situation?

- An industrial process is being disturbed and the automated control system can not cope
- Consequently, the operations team must intervene to supplement the control system.



Unexpected Events Cost 3-8% of Capacity At least >\$10B annually lost in production



Equipment Factors Explained



- Humans Operate the Plant!









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Abnormal Situation Management

A Joint Research Consortium

TOTAL

Founded in 1994

Creating a new paradigm for the operation of complex industrial plants, with solution concepts that improve Operations' ability to prevent and respond to abnormal situations.

www.asmconsortium.org





Human Centered Solutions

Helping People Perform







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ASMC Focus Areas

Understanding ASM

• Focuses on measuring, reporting, analyzing, and communicating the causes and effects associated with abnormal situations



Organizational Aspects

• Focuses on management practices that influence the organizational culture, work processes, staff roles and responsibilities, and valued behaviors as they relate to abnormal situations.



Knowledge and Skills

• Focuses on development and maintenance of a competent work force through training and the creation of a continuous learning environment so that personnel can effectively respond and cope with abnormal situations.



Communications

• Focuses on daily communication and situational dialog among plant personnel and explores opportunities to use information technology that improves site-wide coordination in all situations.



Procedures

• Focuses on all aspects of procedure use such as accessibility, accuracy, clarity, and policy compliance so that personnel can accomplish important tasks at an industrial site, particularly start-up and shut-down.



Work Environment

• Focuses on work place design factors that impact performance of personnel during abnormal situations.



Monitoring

• Focuses on effective design, deployment, and maintenance of hardware and software platforms that support process monitoring, control and support for effective operations.









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Managing Abnormal Situations Supervisory Control Responsibilities



 This model operationalizes the activity types in the operator's supervisory control responsibilities for managing abnormal situations

Adaptation of Supervisory Control Activity models of Jens Rasmussen and David Woods - CMA.



- Effective supervisory control involves processing information at multiple levels of detail
 - From the "big picture" (Orient or Assess) to the "details" (Evaluate, Act or Assess) and back and forth
 - The display hierarchy allows an operator to move between the "big picture" to the "details" as the task or situation requires



The Display Hierarchy is a Critical Solution for ASM



Overview Displays Design Rationale

- Old pneumatic boards supported at a glance awareness:
 - Hearing a gauge moving
 - Pulling out a component to remind you it was in manual
 - Having trend information from strip charts
 - Seeing alarm status on a fixed alarm panel



- Modern DCS show process values across several screens and many hidden displays
 - Difficult to know where the process has gone, how it got there, or what should be done to recover
 - Effective arrangement and visualization of process values is required
 - Operators must actively navigate to find critical information
- Incident investigations often identify a root cause that operators lost track of the "big picture" of plant status

The DCS Must Include a Mechanism to Support Awareness



Overview Displays Common Failure Modes

- There may be numerous reasons why *just having* an overview display is not effective:
 - Incorrect information displayed
 - Poorly displaying the correct information
 - Inadequate navigation hierarchy
 - Operations has the choice to display the overview or not
- Important to use a formal design approach to design displays





Effective Overview Displays

User Centered Design Lifecycle





Qualitative Display Shapes Design Motivation

Previous ASM attempts to visualize process information





Qualitative Display Shapes Shape Design

- Strategy: Identify process functions for equipment types and the critical variables for those process functions
 - Determine the interaction requirements required
 - Create qualitative display shapes that can be reused
- Eight qualitative display shapes have been developed to support operator monitoring of overview displays









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Evaluation of Qualitative Shapes



Shape Evaluation Study Introduction and Purpose

- An evaluation study was completed to assess the benefits of using the new qualitative shapes
 - Purpose: Evaluate the effectiveness of an overview display designed using qualitative shapes that support operator situation awareness during process monitoring activities



Shape Evaluation Study Detecting Process Deviations

 Detecting deviations to variables can be supported in different ways in the Level 1 overview displays:





Shape Evaluation Study Dual Task Evaluation Approach

Dual-Task Evaluation Approach

 Rationale: Operators rarely monitor without simultaneously doing other critical tasks (e.g., completing standard operating procedures, managing field activity, etc.)





Shape Evaluation Study

 Using the Functional/Qualitative Overview Display improved operator situation awareness

Situation Awareness Performance	
	Difference (%)
Percentage of changes detected (Level 1 SA)	+16.9%
Percentage Accuracy to Probes (Level 2 SA)	+6.4%

- Choice of Functional versus Schematic display layout driven by amount of data needed to support interaction requirements relative to display space available
 - Results of this study suggest that schematic information (vessels, flow lines) may not be value added in a Level 1 Overview display for supporting operator situation awareness

Conclusion



- Abnormal Situations remain a significant cost to process industries
- ASM Consortium has contributed to significant understanding and technical solutions
- Significant research continues in diverse areas including operator competence, user interface, alarms, procedures, risk management

