Improving Procedural Operations

Chris Morse
Andrew Ogden-Swift

Honeywell
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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.

An Abnormal Situation Impacts Safety, Environment, Profitability
Human Error and Abnormal Situations

Causes of Process Upsets
- Human error: 20%
- Equipment failure: 40%
- Other: 40%

Causes of Equipment Failure
- Operating out of range: 76%
- Improper design: 5%
- Improper maintenance: 5%
- No defect found: 2%
- Improper installation: 2%
- Improper material: 10%

70% or More Due to Human Performance Issues

Presented by N Kosaric at 2005 Defect Elimination Conference
UK HSE publication states:

“It is estimated that up to **80%** of accidents may be attributed, at least in part, to the actions or omissions of people.”
Aspects that Impact Operator Performance

Organizational
- Management practices that influence the organizational culture, work processes, staff roles and responsibilities, and valued behaviors

Knowledge
- Development and maintenance of a competent work force through training and the creation of a continuous learning environment

Communications
- Communication and situational dialog among plant personnel and use information technology that improves coordination in all situations.

Procedures
- Ensure procedures are clear, intelligible, compliant with policy, accessible and up to date

Environment
- Work place design factors that impact performance of personnel (vigilance, distraction)

Monitoring and Control
- Effective design, deployment, and maintenance of hardware and software platforms that support process monitoring, control and support for effective operations.
Maximize Operator Effectiveness

**Effective Operators**

- **Control system design**
  - Automate tasks where humans are ineffective
  - Design system considering human performance

- **Ensure scope is manageable**
  - Normal operation
  - Major procedures
  - Upset

- **Train operators to run process through control system**
  - Normal operations
  - Procedures
  - Abnormal situations
<table>
<thead>
<tr>
<th>Digital Systems Excel</th>
<th>Approach</th>
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<tbody>
<tr>
<td>Very fast response required</td>
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<tr>
<td>Repetitive</td>
<td>Automate</td>
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<tr>
<td>Complex, high risk tasks or calculations</td>
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<tr>
<td>Response when operator overloaded</td>
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<tr>
<td>Infrequent tasks</td>
<td>Automate or provide guidance tool</td>
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<td>Storage and retrieval of large amounts of information (eg operating envelope)</td>
<td>Information system</td>
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<table>
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<tr>
<th>Humans Excel</th>
<th>Approach</th>
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</thead>
<tbody>
<tr>
<td>Pattern recognition</td>
<td>Effective presentation of information • Effective design process • Well designed operator interface • consider human capabilities • highlight important information • minimize cognitive load • ensure situation awareness • enable pattern recognition • fast navigation</td>
</tr>
<tr>
<td>Decision making with limited, imprecise or conflicting information</td>
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<tr>
<td>Determining what is relevant in undefined situations</td>
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“Inadequate management of procedures have not only contributed to disasters such as Bhopal, Piper Alpha and Clapham Junction,…..The main causes are too much reliance placed on procedures to control risk, a failure to follow safe working procedures or the use of inadequate procedures”
One ASMC member company noted:

- “A disproportionate % of process safety incidents occurred during transient operations….a typical refinery or petrochemical plant spend less than 10% of its time in transient operations – yet 50% of process safety incidents occur during these operations”

An ASMC study identified causes as:

- 6%: Procedure followed incorrectly
- 40%: Procedure wrong
- 51%: Procedure not followed
To help members reduce problems in procedures a guideline has been developed and made available for purchase.

In addition a wide range of additional research has been completed and made available to members.

The document contains 39 guidelines broken down into 5 areas:

- Development
- Content and format
- Deployment
- Maintenance
- Training
• In batch processing procedures have been automated for many years, but this is still rare on continuous plants
  • ASMC has identified this as a significant opportunity to improve safety and production
• Procedural automation can fall into 3 categories
  • Manual Procedures
  • Semi-Automated Procedures
  • Automated Procedures
• Important to use prioritization tool to determine which approach to use where
  • Balance cost against risk of incorrect procedure execution and resulting safety impact or production loss
Procedures and Operator User Interface

- As a minimum, when developing the operator interface, the interaction requirements analysis (IRA) should
  - evaluate all procedures
  - determine the information needed by the console operator to ensure safe and effective procedure execution
- Develop procedure or task-based displays that enable effective procedure execution
- Use pre-task checklists to ensure effective communication
- For procedures that impact all process areas under the scope of the operator (e.g., start up), all aspects of the display will support the procedure
- For other situations the procedural display integrates with the hierarchical displays
Process Display with Procedure Controls

ProcedureListControl
ProcedurePanelControl
StepAndOrPhaseListControl
InformationPanelControl
InstructionListControl
Procedure Automation 3 Layered Procedure Hierarchy

**Plant Area Procedure:** Polymer Type ABC

**Unit Procedure:** Finishing

**Equipment Procedure:** Additive

**Control Requirements:** Additive Pump

- MATERIAL MIX
- REACTOR
- FINISHING
- ADDITIVE
- HEAT
- EXTRUSION
- SAMPLE
- RESET
- VALVE OPEN
- PUMP START
- PUMP OFF

ASM Consortium Proprietary
• Widespread efforts to reduce frequency and impact of abnormal events at Honeywell’s Geismar facility
  – High performance operator user interfaces
  – Simulator-based operator training
  – Early event detection
  – Automated procedures
• Automated procedures applied to catalyst regeneration
  – Minimize feedrate reduction
  – Reduce operator workload
  – Ensure consistent regeneration
• Project success with expected payback time
  – Detailed results not in public domain
Summary

- Reducing abnormal situations is key to improving safety and increasing production

- Operations team error is a key contributor to this

- Need to
  - Ensure operator scope is manageable, particularly during upsets
  - Automate tasks that humans are ineffective at
  - Maximize human performance through careful design of work environments and human machine interfaces
  - Effective operations team training

- Many process safety incidents occur during transient operations and so procedures for these need attention
  - Proper design and maintenance of procedures
  - Access to procedures
  - Appropriate automation and operator interface
  - Effective training in procedures