Operator performance as a function of alarm rate and interface design

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Performance Shaping Factors

Operator Performance

- Interface/Information System
- Workspace/Ergonomics
- Organization & Staffing
- Selection & Training
- Job Design
- Automation/System Demands
Alarm Rates
• 1 per 10 min
• 2 per 10 min
• 5 per 10 min
• 10 per 10 min
• 20 per 10 min

Alarm Displays
• Categorical
• Chronological

Operator Performance
Experimental Flow Chart

Participant Volunteers

Demographic Survey

Training PowerPoint

Demonstration/Familiarization

Quiz

Yes

Participant Passes Qualification?

No

Eliminate Participant

Subjective Usability Questionnaire

Day 1

(Approximately 1hr 45min)

Day 2

(Approximately 1hr)

Refresher Training

Complete Experiment (Random-5)

Complete Experiment (Final-5)

Qualification Assessment
Experimental Measures

Independent Variables
- Alarm Rates
- Alarm Windows

Dependent Variables
- Time Taken to Acknowledge Each Alarm
- Response time to initiate corrective action
- Fraction of Abnormal Situations Successfully Dealt With
- Accuracy of Response

Operator Performance
Descriptive Statistics - Mean Reaction Time (Seconds)
### Reaction Time (All Alarms)

#### Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>Prob &gt; F</th>
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#### Effect Tests

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Reaction Time (All Alarms)

- 20 alarms in 10 minutes using a chronological display is statistically different than 20 alarms in 10 minutes using a categorical display.
- 20 alarms in 10 minutes for either display is statistically different than any other alarm rate using either display.
- 20 alarms in 10 minutes doubles or triples their response time.

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<td>1010,1 C</td>
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<td>110,2 C</td>
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***Levels not connected by same letter are significantly different

Note
1-Chronological
2-Categorical
• Current alarm metrics may be too conservative
• Presentation method has a significant impact
• Operator performance impact can be measured
• However –
  • Students?
  • 10 minutes?
Repeat initial experiment

- With refinery operators and pipeline controllers

Longer time duration

- Expose to alarms for 60 minutes
- Refinery operators and pipeline controllers

<table>
<thead>
<tr>
<th>Treatment Condition</th>
<th>Alarms per 10 minutes</th>
<th>Chronological</th>
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<tr>
<td>30</td>
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Questions?