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Structured Approach to Shift Handover Improves Situation Awareness

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Topics

- Introduction
- Background to problem
- Experiment Overview
- Experiment Details
- Project Results
- Best Practices
- Conclusion

Introduction

- In the refining industry, control room and field operators document their daily activities using shift logs
- Shift logs are an important part of the shift handover process and are the mechanism by which activities are coordinated and situation awareness is shared across shifts
- Industrial research has argued for the benefits of imposing structure on shift handovers in the form of structured logs, checklists, and displays

Background

- Approximately 80% of industrial operations lack a structured approach to shift handovers
- Numerous disasters have illustrated the potential consequences of poor shift handovers
- Lack of structure increases likelihood that critical information will be missed and misunderstandings will occur
- Value of a structured approach has never been demonstrated experimentally

Background (Cont'd)

- Examples of disasters attributed in part to inaccurate or incomplete communication of information from shift to shift
  - 1968: Fire and explosion on the Piper Alpha offshore platform due to poorly documented relief valve status
  - 2002: Pipefitter exposed to toxic chemical at an undisclosed facility due to poorly documented tank maintenance status
  - 2005: Fire and explosion at the BP refinery in Texas City, TX, due to failure to log information, resulting in flammable liquid overfill condition

Background (Cont'd)

- Most common causes of incidents related to shift handover
  - Poor logbook design
    - Lack of structure
    - No clear indication about what to log and how to structure entries
  - Poorly conducted shift handovers
    - Lack of complete and accurate reporting
    - Reliance on operator memory
    - Time pressures
    - Ineffective two-way communications

Recent Experiment

- Shift handover experiment was sponsored by ASM® Consortium and conducted by Engen Petroleum, Ltd., Honeywell, Inc. and Nanyang University of Singapore
- Engen is an Africa-based energy company focused on downstream refined petroleum products
- Engen's Durban, South Africa, refinery has capacity to refine 135,000 barrels of crude oil per day

Recent Experiment (Cont'd)

- Experiment at the Durban refinery compared the quality of shift handovers using a structured checklist-integrated logbook to a traditional, less structured logging approach
- Tests focused on shift handover between first shift and second shift operators
- Checklist-integrated shift log provided sub-categories of information, which prompted operators to acknowledge each detail even if there was nothing relevant to report
- To ensure statistical robustness, ten test trials of the semi-structured handover and ten trials of the structured handover were conducted and observed

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Recent Experiment Details

- Standard Engen logbook

Safety

Injuries

1 person sustained minor injury due to the steam burns. Injury no 3614

Incidents

Steam line ruptured releasing steam. Incident no 3245

Environment

2 Noise complaints received when steam line ruptured. Noise levels recorded West of the mosque: 67/68 and South of P69: 69/72.

BLOWDOWN

None

Energy

No changes.

People

Shift supervisor: Arnold
Debutaniser: Marko
Depropaniser: Lindi

Equipment

None

Shadowplant

Production Performance

Heavy feed was increased to 360 and light feed to increased to 15m3/d for ullage constraints at tankage.
Instrument technician took a permit to replace the positioner on 11FV19, now 11FV19 is on bypass control.
Debutaniser was shutdown when the steam line ruptured.
Permit issued to maintenance to do repairs on the steam system, so repairs are in progress.
Permit issued to DCS to replace the screen on TDC.
Chemical truck on standby to offload chemicals to the unit.
Borehole readings: No1 = 307803 and No2 = 704644

Recent Experiment Details (Cont'd)

- Checklist-integrated logbook

Health, Safety, Environmental

Safety or Environmental limits exceeded or issues. Reported?
There was a explosion in substation,still investigating cause of incindent.
3 injuries report no 3245.
Injury no 3614
Flared for 5 minutes.

SO2 exceedances
none

Disabled and/or nuisance alarms
Nuisance alarms repaired 11HS14A-F. 11HS19A-D,11HS62,66,68

Emergency Shutdown Systems or Relief Systems bypassed or blocked in
None

MOCâ€™s implemented or initiated during shift. Review for understanding
11PC16 overheads alarm setting was changed from 1600 to 1400.

Operations

Operating plan status (rates, specs, yields, energy, special sample, etc.)
C4's was reduced to 0.9% as per plannersd request.
Unit was shut down due to explosionj in substation.

Operating Instructions Status (special instructions, orders, etc.)

Charge increases, decreases, composition changes
none

Process lineup changes (off spec product corrective actions, tank transfers, etc.)
Tank 2[offspec] was full, Xed to Tank 4

Process controls or instrument problems or issues (vessel & tank levels)
none

Chemicals or catalyst inventories and/or deliveries
Chemical truck still waiting to offload from previous shift,unable to offload due to explosion in substation, truck has been sent in to ofload and busy offloading.

Inventory trends, issues, threats
None

Equipment out of service, backup equipment unavailable (pumps, fans, etc.)
P63 and P69 not yet handed back

Equipment/control valve bypass open
none

Maintenance

Maintenance work in progress / scheduled. Status
Still trying to repair P63 and P69.
E110G/H overheads fan belts installed and handed back.

Preparation of equipment for maintenance (PMâ€™s, regular maintenance, etc.)

Permits: equip locked out/ instrument work, DCS system work

Emergency Notifications

Any new information since logbook submission

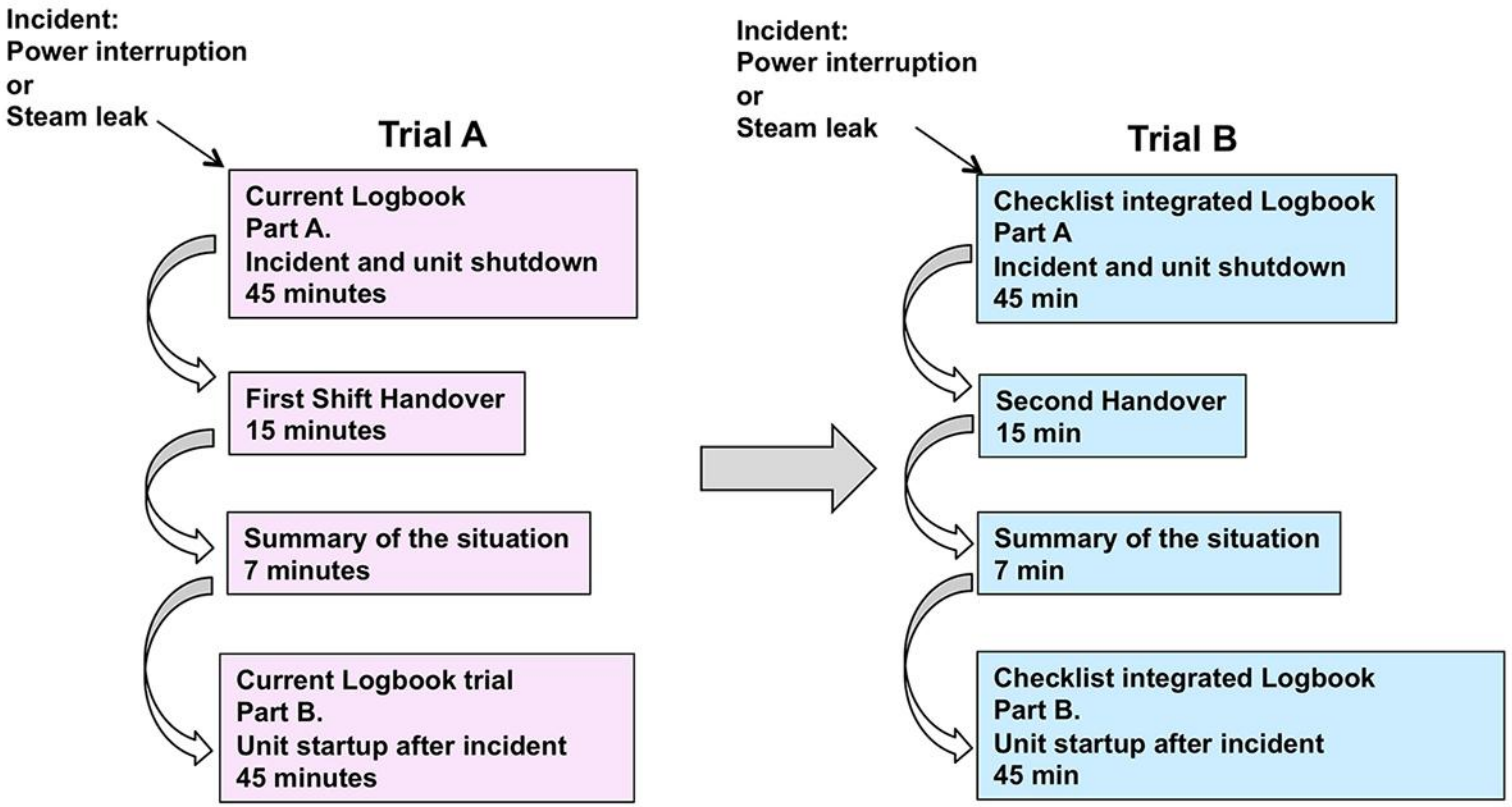
Other information not covered above

Recent Experiment Details (Cont'd)

- Test plan and participants
  - 20 console operators with varying experience
    - 1 to 25 years behind DCS (median = 6.5)
    - 6 to 35 years of operations experience (median = 20.35)
    - 27-62 years of age (median = 39.5)
  - 20 operators → 10 pairs of Operator 1 & Operator 2
    - Trial A: Operator 1 hands off to Operator 2
    - Trial B: Operator 2 hands off to Operator 1
    - New integrated logbook introduced during every second trial of the day
    - Two scenarios (power failure & steam leak) alternated between Trial A & B

Recent Experiment Details (Cont'd)

- Experiment protocol



Recent Experiment Details (Cont'd)

- Operator test setup

Recent Experiment Details (Cont'd)

- Experienced operators were put through two simulated emergency scenarios
  - Steam pipe rupture
  - Power failure that caused pumps to fail
- The scenarios were designed to force a significant amount of interaction between the console operator, field operators, supervisor and other plant operators
- Operators had to recognize abnormal situation, shut down affected unit, and communicate status of situation to second shift operator during shift handover
- Second shift operator's task was to understand situation and safely bring unit back into operation

Recent Experiment Details (Cont'd)

- Events of each scenario were designed to include at least one instance of each information category in the checklist-integrated logbook, thus generating a significant number of key items of information affecting unit startup during the second shift
- Additional events, not related specifically to the checklist, were included in the scenarios to serve as distractions
- Scenarios were designed to force a significant amount of interaction between console operator and various other plant personnel such as field operators and supervisors, role-played by senior operations engineers from the Engen refinery

Recent Experiment Details (Cont'd)

- Data collected during experiment
  - Digital audio recording of the entire experimental session
  - Completed Shift logs
  - Still photos
  - Scripts and probes

Experiment Results

- Engen's experiment showed the benefits to situation awareness that derive from the more structured shift handover approach
  - Checklist-integrated logbook generated higher-quality log entries compared to model logbook entries generated by Engen operations experts (+18.6%)
  - Second shift operators were able to provide more accurate and comprehensive account of the unit situation (+9%)
  - Operators were better at answering questions without the need to consult supervisors and team members (8%)
  - Structured handovers took only a minute or so longer than those conducted in less structured way (+16%)

Project Results

- Based on the experiment outcome, a structured shift log has now been rolled out at the Engen refinery
- Although the introduction was generally successful, it revealed some key issues
  - Structured logbook is much longer than the previous electronic logbook
  - Acceptance of the log as a structured handover tool has not been fully entrenched
  - Too much usage of the “Other” fields to communicate information remains

Project Results (Cont'd)

- Engen's ongoing change management effort will address remaining issues
  - Follow up training to reinforce behavior change
  - Development of separate shift handover report that is a distinct subset of the full reporting log

Best Practices

- Engen's experience with the structured shift handover experiment has been used to implement the following best practices
  - Use structured shift logs clearly indicating what should be reported in the handover presentation
    - Structure shift logs around vital categories and subdivisions of information needed by incoming second shift operator
  - Set clear expectations for complete and accurate shift handovers and for individual responsibility
    - Require outgoing first shift operator to acknowledge every key category of information in the logbook during shift handover, even if no new events have occurred during his or her shift

Best Practices (Cont'd)

- Plan ahead for sufficient time to conduct a complete shift handover
- Train operators in the skill of conducting effective shift handovers and in effective two-way communication
- Emphasize to both first and second shift operators that they have a joint responsibility for effective communication of the situation

Conclusion

- Shift handovers are more effective when supported by a structured shift log based on a checklist of important categories of plant information
  - Differences are not large, but evidential statistical trends exist
  - Results are consistent across all measures of shift handover effectiveness
- Structured approach reduces risk that critical information is not communicated during a shift change
- Accurate and consistent understanding of plant situation is shared from shift to shift

Question & Answer

Thank You