An error management approach in aviation and air traffic control

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Error detection in aviation and ATC

- Almost half of the errors went undetected but only 2 % had critical consequences (normal airline operations, Thomas, 2004)
- The majority of errors were detected mainly by ATC and, to some extend, by the crew
- Error detection increased with cooperation, contingency planning & workload management
Detection of slips, lapses & mistakes

- Detection was higher for slips and lapses but lower for mistakes (Sarter & Alexander, 2000)
- Aircrew and ATC were more active in detecting slips and lapses
- Mistakes were difficult to detect as others did not know the intention or strategy of the person involved
How active are people in error detection?

- Half of the detected errors were based on observations of poor outcome of actions.
- A quarter of the detected errors were caught incidentally by a routine check.
- Only a quarter of the detected errors were caught by some form of proactive strategy.
A pilot study to support mindfulness and error detection

- **Objectives**
  - Identify proactive strategies that support mindfulness and error detection
  - Examine how mistakes can be caught while an assessment or plan is considered

- **Methods**
  - Analysis of ASRS reports
  - Observations of air traffic controllers
Stages of error detection

**Conceptual stage**
- Incomplete, conflicting, unreliable data

**Execution stage**
- Masking effects, diffused data, hard to integrate data

**Assess situation**
- Conflicting goals, need to modify quickly, time pressure, multiple attempts required

**Plan course of action**
- Acting & monitoring, coordinating multiple tasks, looking up procedures

**Evaluate outcome**
- Plan course of action

**Rehearse & put in action**
- Assess situation
Awareness-based detection

- Makes an effort to detect missing cues
- Makes an effort to find ‘hidden assumptions’
- Tests the plausibility of assumptions
- Tests evidence and does not ‘explain it away’

- Incomplete explanations
  - Tests the plausibility of assumptions
  - Makes an effort to find ‘hidden assumptions’
  - Makes an effort to detect missing cues

- Inconsistent explanations
  - Tests evidence and does not ‘explain it away’
  - Tests the plausibility of assumptions

- Unreliable assumptions
  - Tests the plausibility of assumptions
  - Makes an effort to detect missing cues
  - Makes an effort to find ‘hidden assumptions’
Planning-based detection

- **Environment (Threats)**
  - Continues plan if cost of change is high

- **Change Plan**
  - Anticipates weaknesses in plans
  - Regulates complexity & coupling

- **Avoid threats**
  - Question/ test the plan

- **Mitigate consequences**
  - Considers a timescale for questioning
Action & output-based detection

- **Rehearses future tasks**
- **Carries out pre-action checks**
- **ACT**
- **Masking effects**
- **Considers masking effects**
- **Rehearse**
- **ACT**
- **Delays**
- **Monitor outcome**
- **Re-evaluate**
- **Examines pattern of changes**
- **Verifies sensor accuracy & reliability**

- Creates reminders & barriers
### Attitudinal factors in error detection

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<th>Description</th>
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| **1** | Vigilance and alertness  
(‘making the familiar strange’) |
| **2** | Awareness of vulnerability to errors  
(widens perspectives, opens up to different views) |
| **3** | Awareness of degradation  
(‘drifting out of the loop’) |
| **4** | Coping with frustrations from errors |
## Team factors affecting error detection

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<tbody>
<tr>
<td>1</td>
<td>Assertiveness</td>
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<td>(balance with ‘tact &amp; consideration’)</td>
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<td>2</td>
<td>Cross-checking others and monitoring for signs of fatigue</td>
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<td>3</td>
<td>Communication of intent supports re-planning and recovery</td>
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<td>4</td>
<td>The ability to adopt multiple perspectives (understand intent &amp; choice)</td>
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Detection increases “cognitive burden”

- **Awareness-based detection** calls for a state of ambivalence (e.g., engage in belief & doubt, “make the familiar strange”, test data and assumptions)

- **Planning-based detection** requires people to forgo procedures in favor of what amounts to ‘re-inventing the wheel’ (see old things in new ways, stay ahead of situation, reduce coupling, set milestones to review)

- **Action-based detection** calls for more conscious attention (e.g., rehearsing things, thinking out possible errors, running a conscious check on routine tasks, cross-checking)
Error Management Training
-- ‘Getting the balance right’ --

Resilient actions

Cognitive burden
Error Management Training
-- General approaches --

- Embed error management in CRM (e.g., sharing of intentions, cross-checking, assertiveness, and vigilance)
- Blend cognitive strategies with technical skills by designing simulator exercises (e.g., missing cues, masking effects, poorly integrated cues)
Error Management Training --
Training methods & practice --

- Over-learning can reduce ‘cognitive burden’
- Watch video-taped feedback sessions to detect errors of others
- Replace leaders to support skills in presenting the ‘big picture’
- Methods of communicating ‘intent’ behind orders and plans
- ‘Crystal ball technique’ (counteracts overconfidence, prompts introspection)