Automation Dependency—Ensuring Robust Performance in Unexpected Situations

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Automation Dependency Challenges

- Crews are trained to rely on automation and envelope protection
  - HOWEVER –
- Automation can also bring the pilot out of the loop
Automation Dependency Challenges

- Causes of Faults
  - Automation could fail or give erroneous information
  - Crews have difficulty managing mode complexity
  - Training of automation failures depends on simulator capability and limitations
  - We are extremely limited in simulating unusual behaviour of automation

- Basic premise still exists:
  - Aviate, Navigate, Communicate
Some examples where Automation played a key role

- Asiana 777 accident, SFO, 2013
- Turkish Airlines 737 accident, Amsterdam, 2009
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- Asiana 777 accident, SFO, 2013
- Turkish Airlines 737 accident, Amsterdam, 2009
- Qantas 32, A380 <- good example of proper management
Man4Gen

Man4Gen is a European study funded as part of the European FP7 2012 Aeronautics and Air Transport programme.

Man4Gen consortium partners:
- NLR (coordinator, the Netherlands)
- DLR (Germany)
- IDT (the Netherlands)
- Linköping University (Sweden)
- Boeing R&T (Spain)
- University of Vienna (Austria)
- Medical University of Vienna (Austria)
- Global Training Aviation (Spain)
- Airbus and Airbus Operations (France)

The project started in 2012 and will run until the end of 2015
**GOAL**: to identify the causality behind incidents and accidents which required manual operations. Recommend short-term changes to procedures, training, flight-deck technology in order to reaffirm proper manual operations.

**Achieved through:**

- **Analysis** of relevant accidents and incidents related to manual skills
- **Analysis** of unexpected and challenging situations
- **Understanding** breakdown of situation awareness
- Developing and performing **experiments** related to unexpected events
- **Analyzing** system monitoring, decision-making and manual control
- **Development of recommendations** for training, procedures and system design
Experiment

**Intention:** to study decision making and risk assessment in response to unexpected and challenging situations

Experiment scenario elements:
- reversion to manual control,
- unexpected and challenging
- active and authoritative decision making

- Crews were observed for actions, communications and behaviour using the Desirable Flight Crew Performance (DFCP) method and the Airbus Assessment and Grading System.

- B747-400 research flight simulator at NLR in Amsterdam, and
- A320 research simulator at DLR in Braunschweig.
Scenario Conditions and Events

- Low fuel state (just enough for one approach and flight to alternate)
- Visibility 20 km, cloud base 2,000 ft AGL, BKN
- Patchy fog, over active threshold, RVR 50 m, other threshold in sight if possible
- Wind shifting to tail-wind during final approach
- Go-around on first approach, decision by crew
- Heading select failure
- Bird strike, engine 1 failure, engine 3 and 4 surge and vibration
- During vectoring into holding: visibility clears up,
Scenario
Measurements

- Instructor Observations
- Video
- Interview
- Questionnaires
- Crew debrief
- Simulator Data
- Heart Rate
- Eyetracking
Expected Behaviour

1. Fly the airplane
2. Identify and confirm the problem
3. Perform recall/memory items
4. Short-term plan:
   - immediate flight path (continue route, holding)
   - consider priority status (Mayday/PanPan)
   - consider emergency return
5. Checklist (Normal and Emergency)
6. Long-term plan
   - identify other threats
   - limits on controllability and performance
   - fuel
   - other environment consideration
7. Make decision (continue, return or divert)
8. Inform ATC, cabin, PAX, company
Expected Behaviour

- Information Management
- Anticipation & Planning
- Decision Making

Diagram shows a cycle with arrows connecting the three blocks.
Observations

• Crews indeed experienced the events in the scenario as “unexpected events”.

• Crews appeared to have more difficulty than expected with the scenario.

• Some cases leading to unstable approaches and very short final line up distances.

• The decision to land as quickly as possible led to abbreviated procedures and checklists, if run at all.

• Crews failed to perform complete threat assessment and made decisions without considering the impact of these decisions.
Outcome – NLR 747 scenario

- 67% of crews performed “multiple engine stall” procedure while the ‘stalling/surging engine’ procedure would have been the preferred procedure
- More than 50% of the crews returned to RWY 06, even though weather difficulties forced them to GA on the same runway two minutes before.
- Other possible/available procedures for the situation were not used
- Lack of energy management
- Captain’s task management and leadership was often poor
Outcome – DLR A320 scenario

• Most crews identified the situation as severe emergency and elected to return as quickly as possible to the airfield

• Majority of crews identified double-engine stall but did not perform “engine stall” procedure after the bird strike

• Some crews did not complete ENG 1 (2) STALL checklist or forgot landing checklist for second approach

• Six crews elected returned to RW25C or RW25R even though they could expect tailwind

• Only three crews stabilized engines, two crews decided to fly idle thrust on both engines for the complete flight after bird strike
Risk Assessment: Situation Awareness and Sensemaking

- Workload increased, situational awareness reduced after birdstrike.
- PF very occupied with flying aircraft after engine failures, potentially “overloaded”.
- Possible/available procedures for the situation were not used.
- Very few crews consciously dealt with energy management.
- Crews with good workload management, leadership, decision-making and communication were more successful.
“Houston, do we have a problem?”

- Eventually, all crews managed to land the aircraft
- Had time but felt immediate threat and forced themselves to land ASAP.
- Decisions were made without the consideration of risks and possible consequences.
Expected Behaviour

1. Identify & Prioritize Threat
2. Information Management
3. Anticipation & Planning
4. Decision Making

Expected Behaviour flow chart:
- Identify & Prioritize Threat
- Information Management
- Anticipation & Planning
- Decision Making

Cycles back to Identify & Prioritize Threat
What’s happening?

Possible clarifications for crew behavior:

• Crews were insufficiently trained for this atypical scenario

• Crews were imposed to maintain PF/PM roles (captain is PF and FO is PM). **Would performance be better if captain was PM?**

• Crews did not always properly perform information and threat management on unusual failures
Project Benefits for You

Training:
• Innovative approaches to target specific training deficiencies:
  • Prevent the dissociation of pilots from automated processes
  • Uphold effective manual control and decision making skills
  • Enable improved objective means of analyzing human behaviour

Procedures:
• Provide crews with guidelines and training toward more effective approaches in managing unexpected, complex and ambiguous situations.

Cockpit Design:
• Innovate new solutions which assist crews in performing faster and more accurate situation assessments in complex situations.
Conclusions: Can we better train to deal with Automation Dependency?

Yes, however,

Requires shift in technology, training and culture

Good scenario design can teach us more about crew behaviour and competencies

Crew observation methods can help you better assess training

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