

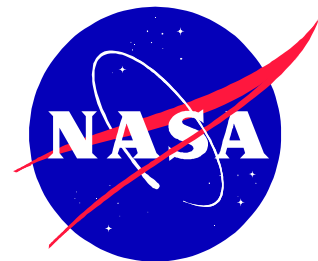
Human Factors of Remotely Piloted Aircraft Systems: Lessons from Incident Reports



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Agenda

- Human challenges of remote piloting
- Problem: Lack of available incident data
- Critical incident technique
- Preliminary results: under-examined issues
- Conclusions



Human Challenges of Remote Piloting

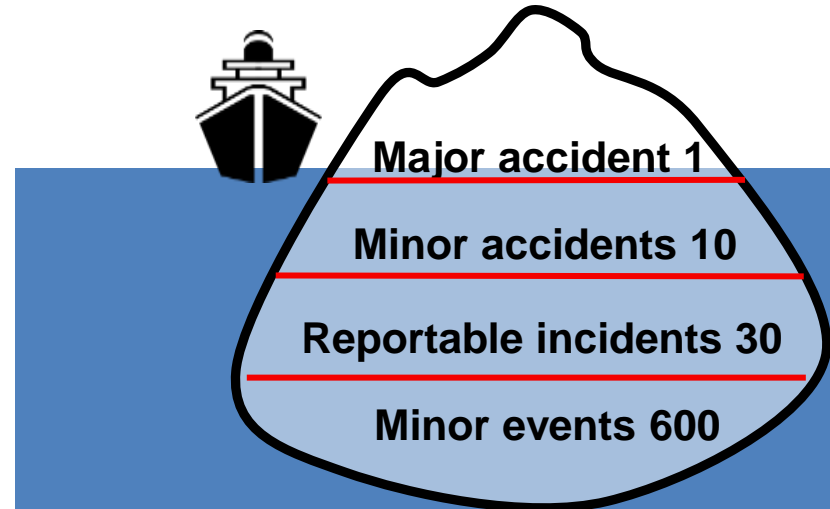
- Loss of natural sensing
- Control and communication via radio link
- Physical characteristics of control station
- In-flight transfer of control
- Reliance on automation
- Flight termination

The Problem

- Lack of data on Remotely Piloted Aircraft Systems (RPAS) incidents
- Relatively few RPAS reports have been submitted to NASA's ASRS by RPAS pilots

Critical Incident Technique

- In 1940s, researchers asked pilots to recall pilot error incidents
 - Many “errors” reflected poor cockpit design
 - Results led to standardized cockpit design in modern aircraft



The Current Study

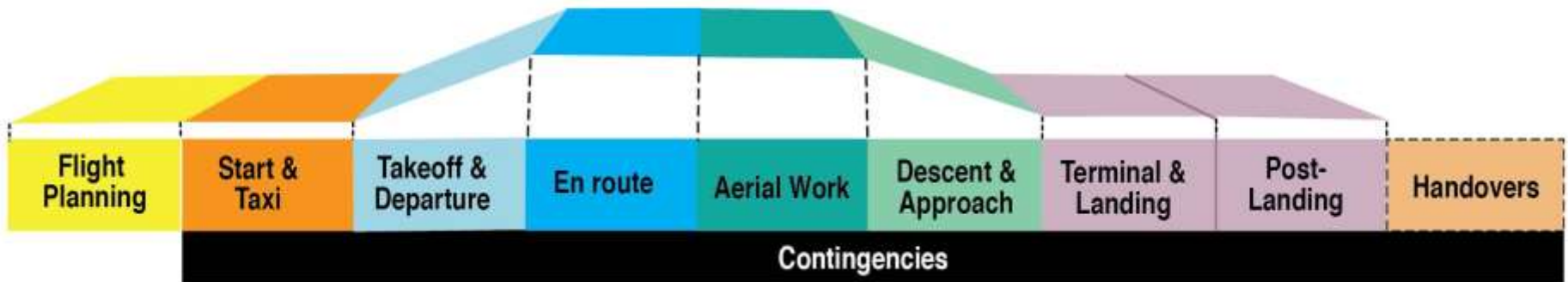
- Goal: Examine the feasibility of a method to collect the operational experiences of RPAS pilots
 - Information will be used to identify needed improvements in control station design, procedures, training, etc
- Will provide independent and complementary data to supplement NASA simulations and flight tests

Approach

- Focus groups with 2-3 pilots at a time
- Participants asked to recall events that they have experienced while operating a remotely piloted aircraft
 1. A hazardous situation or error
 - Could involve the design of the system, procedures, communication, or other issue
 2. The rectification of a hazardous situation or error

Approach

- Participant identities remain confidential
- De-identified incident reports will be made public

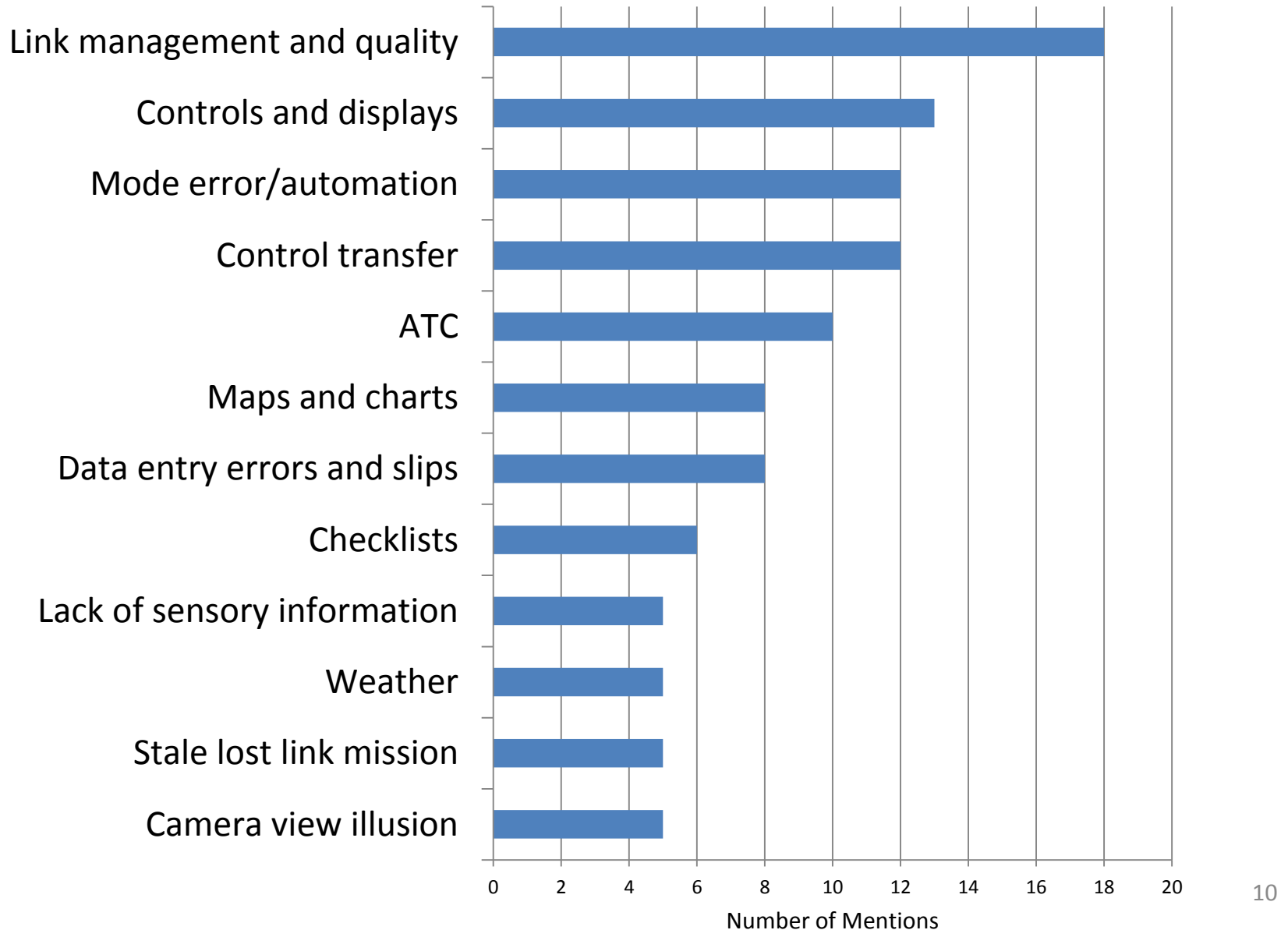


Preliminary Results

- 23 participants
- 90 incidents described
- Weight classes of the remotely piloted aircraft:

Aircraft max takeoff weight	# of reports
Less than 400 lbs	17
2000-15,000 lbs	60
Greater than 15,000 lbs	13

Problems Mentioned in Reports



Example Narrative: Lost link

“We were flying really far out ... about 90 kilometers from the antenna. But I passed some random mountain peak for about one second and the aircraft went into emergency mode. Luckily I had the correct emergency mode programmed. If I didn't, I could've lost the aircraft.”

< 400 lbs

Controls and Displays

- Interfaces may be particularly error-productive
- Keyboard and consumer interfaces
- Shared payload and flight controls

Control Transfers

- Inter-control station mode errors
- Unintended transfers

Seamless



Make before you break



Break before you make



Example Narrative: Inter-control Station Mode Error

“During preflight, handover checks were being done ... we had the aircraft engine at idle with the parking brake set, but when the radio handover switched to XXX, he didn't have the parking brake set and the power was set at 80% The result was the engine revving up, and the aircraft jumping its chocks.”

Example Narrative: Data Entry Errors and Slips

“I went to put the gear down, but instead I turned the SAS [Stability Augmentation System] off using the red emergency button. The aircraft went into a 20-degree bank and 5-degrees nose down. I was able to recover the airplane. I had developed muscle memory with the activation of the SAS disengagement button.”



Stale Lost Link

- Pilot awareness of lost link mission
- Lost link mission needs regular updating
- Lost link mission can be a form of “automation surprise”

Example Narrative: Camera View Illusion

“Depending on how I do the landing [the moveable sensor camera] ...will be used to make sure that we clear the turns. But sometimes, the sensor operator will move the camera, which will make it look like that I’m turning but I’m actually not turning. So I have to concentrate and make sure I don’t respond to that erroneous camera view.”



Conclusions and Next Steps

- RPAS pilots are willing to share their experiences
- Incident reports are helping to identify under-examined topics
- Results will be used to inform
 - Design guidelines for RPAS control stations
 - Input to FAA & ICAO
 - Incident reporting systems
 - Research needs