# Identification of Human Factors in Unmanned Aviation via Pilot Incident Reports
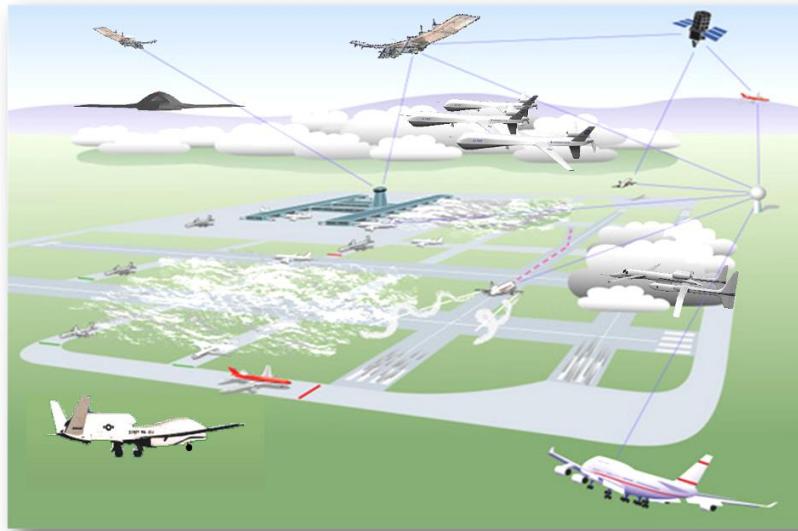
Alan Hobbs*, Colleen Cardoza*, Cynthia Null**

* San Jose State University/NASA Ames Research Center

** NASA Langley
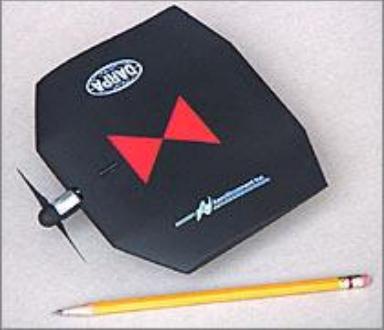
Ground Control Stations

UAS Human Factors

- Reduced sensory cues
- Latency
- Lost link
- Control transfers
- Traffic separation
- Long duration flights
- Flight termination
- Control station design

NASA's UAS Activities

- Operations
  - Ikhana, Global Hawk, Sierra, …
- Research
  - UAS in the NAS Project

Learning from Incidents

- In the 20th century, aviation accidents and incidents led to system improvements
  - e.g., checklists, improved training, fatigue management, improved cockpit design

The Problem

- Lack of data on UAS incidents
- Commercial operations tightly restricted
- Relatively few UAS reports have been submitted to ASRS by UAS pilots

Critical Incident Technique

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

Major accident 1

Minor accidents 10

Reportable incidents 30

Minor events 600
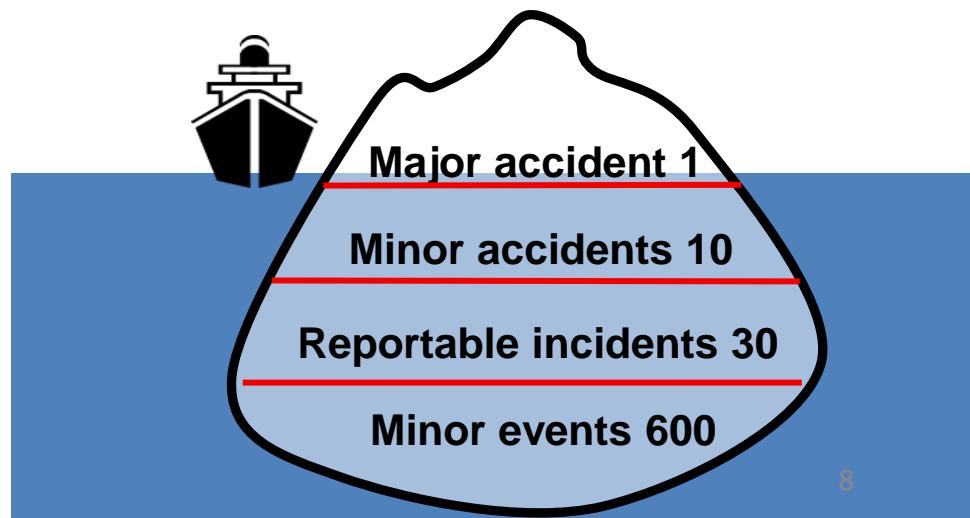
The Current Study

- Goal: Examine the feasibility of a method to collect the operational experiences of UAS pilots

  – Information will be used to identify needed improvements in control station design, procedures, training, etc

- Will provide independent and complimentary data to supplement NASA simulations and flight tests

Approach

- Focus groups with 2 UAS pilots at a time
- Participants asked to recall events that they have experienced while operating a UAS
  1. A hazardous situation or error

     - Could be about the design of the system, procedures, communication, or other issue

  2. A situation where a hazardous situation or error was identified and rectified

Approach

- Participant <u>identities</u> remain confidential
- De-identified incident reports will be made public
- Approximately 40 incidents so far

Manage

- Plan for normal and non-normal conditions
- Make decisions in normal conditions
- Recognize and respond to non-normal conditions
- Handoff control

Aviate

- Monitor and control aircraft systems, including automation
- Monitor consumable resources
- Monitor and configure control station
- Collision avoidance maneuver to avoid aircraft or terrain
- Monitor and control status of links

Navigate

- Control and monitor location and flight path of aircraft
- Remain clear of terrain, airspace boundaries and weather
- Self-separate from other aircraft
- Ensure that lost link procedure is appropriate as flight progresses
- Terminate flight

Communicate

- Communicate with ATC
- Communicate with other airspace users
- Communicate with other flight crew or ground support
- Communicate with ancillary services (e.g. weather)

Possible Phases for Critical Events

Flight Planning	Start & Taxi	Takeoff & Departure	En route	Aerial Work	Descent & Approach	Terminal & Landing	Post-Landing	Handovers

Contingencies
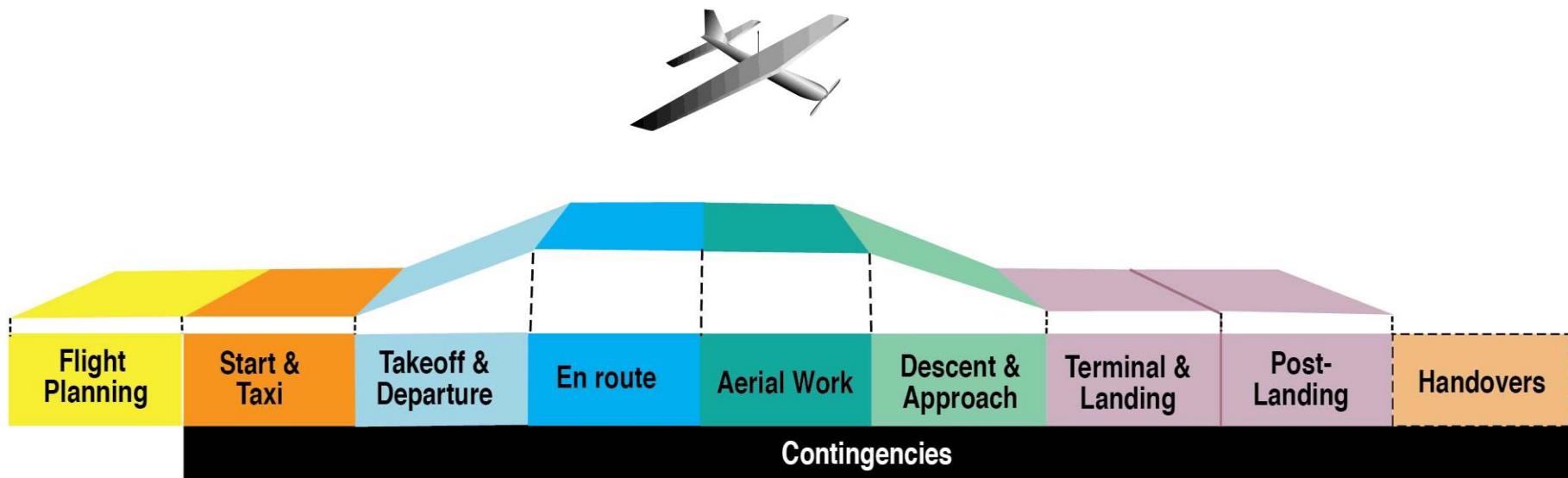
Examples of Emerging Issues

- ## Managing lost link procedures

"We sent the aircraft to a practice area that had terrain. This terrain would affect our line-of-sight LOS communications, and at one point the aircraft descended below the terrain and we lost link. The aircraft started to fly its lost link procedure, which had the aircraft fly towards a predetermined area, which was on the other side of the terrain. The aircraft turned towards this area, which had the aircraft flying straight for the terrain. The aircraft flew past a 'gap' in the mountain range and luckily LOS was re-established allowing a new (and better) emergency mission to be sent to the aircraft... Just in case it lost link again".

- ## Skill-based errors and muscle memory

"I turned the SAS [Stability Augmentation System] off by accident. We use the emergency red button to turn the SAS off, and we do this during normal operations when the ground crew remove the chocks. We do this to make sure the ground crew do not get hit if the SAS moves a flight control surface. I had developed muscle memory with the activation of the SAS disengagement button. One day I was flying and I went to put the gear down, but instead I turned the SAS 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. Now, the procedure is to turn off the SAS using the ..(keyboard).. instead of using the red button.

Examples of Emerging Issues

- ## Handover

"During preflight, handover checks were being done (this is normally accomplished by maintenance crews) to see if the radio handovers between the LRE [Launch and Recovery Element] and MCE [Mission Control Element] worked before we took off. This handover is not routinely done by pilots on the ground –it's usually done in the air. When the handover is done in flight, the procedure is for the MCE to have power set to 80%. At the LRE we had the aircraft engine at idle with the parking brake set, but when the radio handover switched to MCE, he didn't have the parking brake set and the power was set at 80% (airborne handover settings). The result was the engine revving up, and the aircraft jumping its chocks".

- ## Mixing of payload and flight controls

"The …(Ground Control Station)…allowed some flexibility with assigning buttons to do certain functions. There is a button for parachutes. On this mission with a 300 lb fixed wing UA, we wanted to map the parachute drop button to a payload …(function). The button still says "parachute drop" but it was for the payload cycle. During a pilot proficiency check, we found that hitting the parachute drop button also shuts off the engine. The pilot was able to goose it out of idle, and fly it out of a dive. The engine was brought to min idle but not actually to off. Not knowing the "behind the panel features" affected outcome".

Examples of Emerging Issues

- Camera view illusions

"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

- UAS pilots are willing to share their experience
- Incident reports can help to identify topics for future research
- Results will be used to inform
  - Design guidelines
  - Input to FAA & ICAO
  - Incident reporting systems