Unmanned Aircraft Systems: The Known and Unknown

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What is ANSER?

- Fifty year-old spin-off of the RAND Corporation
- Non-profit government contractor specializing in decision support
- Clients include:
  - U.S. Air Force
  - DoD
  - FAA
  - DHS
- Five years’ experience with UAS issues supporting FAA’s Air Traffic Organization
What Is an “Unmanned Aircraft System?”

According to RTCA SC-203:

- “An unmanned aircraft system is an unmanned aircraft and its associated elements required to operate in the [National Airspace System]”
- “An Unmanned Aircraft (UA) is an aircraft operated without the possibility of direct human intervention from within or on the aircraft”
- “The word ‘system’... includes all elements that make up a UAS”

14 CFR 1.1: “Aircraft means a device that is used or intended to be used for flight in the air”
These Are Unmanned Aircraft
... And So Are These...
...And So Are These...
...And So Are These!
How Are UAS Different from Manned Aircraft?

- “See and avoid” (the simplest distinction)
  - Lots of interest in technical solutions
  - Often overlooks the need of the *manned* pilot to “see and avoid”

- Remote presence of the pilot
  - Situational awareness
  - Risk to the pilot

- Economics
  - Expendability of aircraft
  - “Price of admission”
The Known and the Unknown

- **We know:**
  - How to build aircraft
  - How manned aircraft pilots should be trained

- **We don’t know:**
  - How to certify UAS pilots (yet)
  - How to certify ground control systems (yet)
    - The information UAS pilots need to support their situational awareness
  - How the air traffic system will respond to the presence of UAS
Variability Among Systems

- Pilot/aircraft interface
- Lost link behavior
- Compatibility with different classes of airspace
  - Line of sight versus beyond line of sight
- Pilot situational awareness
Pilot/Aircraft Interfaces

<<< Predator >>>

<<< Raven >>>
Loss of Control Link

- There is no standard behavior associated with a UAS going “lost link” --
  - Proceed on last programmed heading(s) until timer expires?
  - Climb to re-acquire link?
  - Orbit in place?
  - Proceed direct to pre-designated waypoint?
  - Go ballistic?
Class D Airspace
UAS-Related Hazards

- Loss of control/comm links
  - Sustained loss of control link
  - Sustained loss of data link
  - Lost communications

- Other system issues
  - UA system failures
    - Degraded control
    - Uncontrollable
      - Engine malfunction
  - Positional ambiguity
  - UAS latency
  - Crosstalk (command intended for one UA received and acted upon by another)

- Outside interference or intrusion
  - Wake turbulence on UA
  - Unauthorized aircraft in Class D airspace
  - UAS ops team human performance

- Internal/external visual limitations
  - Lost visual contact with unmanned aircraft (UA)
  - Inability of UA to detect/respond to visual cues (e.g., hold short line, light gun signals, etc.)
  - Other aircraft unable to see UA

- UAS operations team human performance
  - Lack of standardized UAS-specific training and currency
    - Pilot
    - Observer
    - Controller
  - Unrecognized/unexpected meteorological change
Pilot Situational Awareness

- Easy – *nothing* is standardized!
  - Vehicle position
  - Own position
  - Vehicle health
  - Surrounding traffic

- Everything normally perceived directly by an on-board pilot must be downlinked to a ground control station; implications include:
  - Spectrum requirements
  - Bandwidth requirements
  - On-board power
Frequently expressed goal of UAS development and regulation is “integration” into shared airspace

- Variously portrayed as operating on non-interference basis, “file and fly,” operating at will, etc.

Regulators’ challenge:

- Develop UAS pilot certification standards
- Develop UAS airborne and ground-based component certification standards
- *Bridge the gap between the above and the capabilities of all other pilots and aircraft in the skies today*
UAS Test and Evaluation Issues

- Operational:
  - Where can UAS be tested safely?
  - What does each system need to be tested for?
  - How can UAS be evaluated for impact on the existing aviation system?

- Process:
  - How can the T&E community avoid being an afterthought in fast-moving UAS development efforts?
  - How can UAS manufacturers with minimal aerospace experience be educated in proper T&E practices?
Modified Cooper-Harper (MCH-UVD) Scale

Does the display facilitate efficient decision-making?

YES → Display is Acceptable

NO → Deficiencies Warrant Improvement

YES → Is the depicted display what is needed to analyze the situation?

YES → Deficiencies Require Improvement

NO → Mandatory Re-design

YES → Is the displayed information easily acquired?

YES → Excellent and Highly Desired

Good w/Negligible Deficiencies

Minor, Tolerable Deficiencies

Moderately Objectionable Deficiencies

Very Objectionable Deficiencies

Deficiencies Require Improvement

Major Deficiencies (unclear, slow)

Major Deficiencies (excess overhead)

Major Deficiencies (requires interpretation)

Deficiencies Warrant Improvement

Major Deficiencies (cause degraded human performance)

Major Deficiencies (critical info is missing/not possible to retrieve)
T&E Community Engagement in UAS Challenges

Flight Test Engineers

Test Pilots
Thanks for your attention!