Human Performance Issues in Remotely Piloted Aircraft Systems

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NASA-UAS Integration into the NAS

ICAO: Remotely piloted or piloted: sharing one aerospace system
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Legacy from Manned Aviation

• Good
  – Safety
  – Professionalism

• Bad
  – Slow, reactive regulatory process
  – Flying “economy”
  – High entry price

• Ugly
  – High Human Error rates !!
Human Performance In RPAS

Aviation accident stats
• Although percentages vary, most would agree that somewhere between 60-80% of aviation accidents are due, at least in part, to human error (Shappell & Wiegmann, 1996).

RPAS accident stats
• About 100 Predator Accidents from 1997 – 2005 ; 51% mishaps involving crewmember acts (Tvaryanas, 2005)
• Tvaryanas (2004) on mishap epidemiology states that Human System Interface (HSI) issues are discussed in 89% of the Predator accidents and are cited as a causal factor in 44% of those accidents.
• Mishaps in the first few years were often attributed to equipment failures, while mishaps in the last three years were predominantly operator error (Nullmyer, et al, 2007)
• As drone use has taken off, human error remains a leading cause of unmanned aerial vehicle crashes. (Popular Science, 2013).

• Why ? How can we do better ?
Current UAV Operator Interface Issues

- Too many inputs required to implement commands (e.g., 22 key strokes to turn on the auto pilot)
- Visualization is poor and perpetuates mistakes
- Multiple screens require significant mental integration to obtain mission/battlespace awareness
- Multiple keyboard/input devices required
- Visualization is poor and perpetuates mistakes
- Extra workspace required
- Multiple separate comm devices
- No decision aiding/support technology
- Varying methods to input data
- Highly loaded visual channel
- Limited alert cues to warnings where messages can be hidden
- Non-intuitive multilayered menus
- Narrow visual field of view
- Lack of system feedback regarding task completion
- Add-on systems (i.e., Falconview) provide needed functionality but cannot interface directly with core GCS
- Poor ergonomics
- Lengthy process to handoff vehicle control
- Numerous alphanumeric status displays

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Q: How do I TURN **ON** the Fuel Heaters?

Fuel Heat Inhibit

**Disable / Enable**

A: Disable the Inhibit…
A double-negative!
UAS?

Well....What if you stepped into your cockpit...

...and you lost 4 of your 5 senses?

You only have vision!
How can we replace the information?

- You can’t hear the engine rpm fluctuating
- You can’t feel vibrations, accelerations or motion
- You can’t smell the fuel leak
- You can’t taste the electrical fire smoke
- AND, you lose vision in one eye, 30º FOV!
- WELCOME to UAS flying!
Is it Pilot Error?

A little background:

• April 26, 2006 (NTSB, 2006)
• Predator B with two side-by-side consoles
• Power lever operates in two modes
  – Sensor – controls Iris, middle position locks
  – Pilot – engine control, middle position shuts off fuel

Events:

• Pilot’s console “locked-up”
• Pilot took over sensor console
• Did NOT perform transfer checklist
• Power lever was in middle position (now fuel shut off)
• Warning tone (but all the same; thought to be temp lost link)
• 3:50 a.m., A/C impacts the ground near Nogales, AZ
“This thing’s kind of climbing like a pig. Climb, you pig. . . . Boy, this is going to be tight. . . . Okay, interesting. We are falling out of the sky.”


“Drone just pitched up. Drone’s pitching over. Drone is uh, crashed and destructed, at uh, the end of the runway.”

Unidentified pilot of a chase plane that was following a QF-4E target drone before it crashed at Tyndall Air Force Base in Florida on July 17, 2013.

“We’re in the soup here. . . . Dude, uh, we’re not sure what the aircraft is doing. . . . Yeah, we crashed.”


“Whoa. . . . I don’t know what the hell just happened.”

“Where the hell is — where is the runway? It’s all the way over here. I overshot. Oh, shit. I think we lost the engine. Oh, shit, oh damn, oh my God, what is that? . . . What was all that stuff I just hit?”

Air Force Capt. Matthew Scardaci as his Predator crashed into a row of empty shipping containers at Kandahar Air Base on May 5, 2011.

“I couldn’t tell which way it was turning, or if it was straight, if it was upside down, or if it was right-side up. . . . I couldn’t grasp what was happening with the aircraft. And he said he thought it was upside down.”

Unidentified Predator pilot to investigators trying to determine how and why she flew the drone upside down before it crashed near Kandahar Air Base on Jan. 15, 2010.

“Um, I guess I’ll just be blunt and say not well.”

The Predator pilot who flew upside down, when asked by investigators how well her training had prepared her for such an incident.
A VERY Partial List of Issues

- Pilot selection/ certification/ training
- GCS database compatibility
- Lack of GCS Standards
- Pre-flight planning
- Lack of sensory cues
- GCS Human Factors Best Practices
- Clumsy automation
- Detect and Avoid
- Well Clear
- Collision Avoidance
- Lost Link
- Visual clearances
- Surface operations
How can the industry reduce human performance errors?

• Introduce Human Factors early on – in a “human-centered” design process
• Design to let people perform the tasks where they are superior
  – Novel conditions
  – Pattern recognition
  – Decision making
• Let Computers do what they are good at
  – Number crunching
  – Vigilance
  – Integrating diverse sources and large amounts of information
• Don’t automate with “leftover” principle
• Design robust, flexible automation that is mission/scenario driven
A Few Current Efforts

• NASA – UAS Integration into the NAS
  – Human Systems
    • Displays, alerts, GCS
  – Communications
  – Detect and Avoid

• DoD
  – AFRL – Airborne Sense and Avoid
  – Army – Ground Based Sense and Avoid

• FAA Technical Center
  – Minimum Information displays