Flying Unmanned Aircraft: A Pilot’s Perspective

“It’s not un-piloted...”

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Presented to:
Human Factors Conference
California State University,
Long Beach, CA March 2012

Note: The information in this presentation is the author’s and may not reflect official NASA policy
TOPICS

• NASA MQ-9 *Ikhana* (Predator-B)

• Pilot – Vehicle Interface Design

• NASA RQ-4 Global Hawk

• Defining “Pilot” in the UAS world

• UAS Wildfire Geo-location Mission
NASA MQ-9 Ikhana

*Ikhana* = Native American Choctaw word for...

“Intelligence”
“Learning”
“Awareness”
MQ-9 Reaper/ Predator-B

MQ-1 Predator -A
Two nose-mounted cameras: Color Visible & B&W Infrared
Initial power-up, fueling, engine start, and local area flying.

C-Band Line-of-sight antennas and remote camera.
MQ-9 Ground Control Station (GCS)

Two Pilot Stations
Provides situational awareness of people, equipment, and vehicle movement near aircraft.
Ground Control Station:
People talk
Phones ring
People come and go
Long-duration missions. Multiple crews: Hand-overs

Fatigue
Boredom
Complacency
Shift work = “day sleepers”
So, what’s it like to fly a UAS?

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

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

You only have vision!
Only 1 sense?

- 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, only 30º FOV!
- WELCOME to UAS flying!
With decades of evolving cockpit design, today’s aircraft exhibit common standard control and display formats and arrangements.

Example: The “T” arrangement
It works in many types, small and large.

Cessna 182  Boeing 737
Use of the Tactile sense

Different shapes of actuators enable the pilot to direct attention elsewhere...while activating systems.
Digital Information Can be displayed in Analog Format
Example of Display and Control Issues

IFF Transponder “IDENT” Task

1. Remove right hand from control stick
2. Move curser to tracker display
3. Click on TOOLS menu
4. Scroll to IFF
5. Click to open IFF window
6. Click “IDENT” button
7. Click “APPLY”

Accessed by trackball and Left/Right buttons
Q: How do I TURN ON the Fuel Heaters?

Fuel Heat Inhibit

Disable / Enable
“How far can you see a plane?”

Light
Contrast
Color
Texture
Distance
Motion
Shape
Reflectivity
Atmospheric Filtering
Weather
Acuity
RQ-4 Global Hawk
Global Hawk Operation Center
The pilots fly with mouse and keyboard.
Q: What’s a “pilot”?
19th Century Pilot.
• Riverboat Captain
• Skills: River navigation, rudder control, soundings, shovel coal, supervisor…
20th Century Pilot

- Strapped to an airplane, direct interface to controls.
- Motor skills are primary metric of performance
- Increasing use of automation, systems management.
21st century pilot…”fly-by-wire”…. 
•“Remotely” connected to the controls, systems management, monitor autonomous operations. 
•In some cases, motor skills have little/no relevance.

Global Hawk cockpit: 
Autonomous operations. 
Mouse and keyboard controls.
What is a “pilot”? Knowledge, Ability, and Skill Sets
(relative relationships are not necessarily to scale)

What do these people have in common?

- Video Gamer
- Radio Controlled Visual Line-of-sight
- Remotely Piloted Unmanned Aircraft System
- Piloted (manned) Aircraft
What is a “pilot”? Knowledge, Ability, and Skill Sets

(relative relationships are not necessarily to scale)

Video Gamer
Reset Button

Model airplane
Hobbyist
Sometimes...left is right, and vice versa.

UAV Pilot
Skill sets depend on control method

Knowledge, ability, and skill sets

Radio Controlled
Visual Line-of-sight

Plus: Judgment,
experience, flexibility, etc.

Remote Piloted
Unmanned Aircraft System

Piloted (manned) Aircraft

Airmanship / Air Sense / Knowledge: Navigation; Communication protocols; FAA Airspace Rules, Requirements, and Regulations; Terminal area procedures, Weather forecasting and alternate airfield assessment, Mission planning, Emergency procedures, aircraft systems, principles of flight, etc.
Considerations

• Proven human-machine interface standards exist – use them / adapt to UAS as required.

• Extended duration missions and remote operations require new con-ops for multiple crews, circadian shift, etc.

• No single definition of “Pilot”

• Consider a future state, where multiple UAS are controlled by a single “operator”.
  – May blend the roles of pilot and air traffic controller.
Western States Fire Mission
Where is the exact location of fire lines and hot spots?

Where do you employ limited resources? ...and keep them Safe!
FAA Provisions...The COA

• One assigned Flight Level (FL 230), in Class A airspace.
  - Two-way radio communication and transponder.
  - Climbs/descents while in Edwards AFB airspace.
• File flight plan 72 hrs prior, fly 1 of 3 “standardized” routes.
• Demonstrated “Lost Link” ability: Return via same route.
• Emergency landing sites: Military only.
• Designate “set-down sites” (fields, lakebeds) if engine failed.
• MQ-9 demonstrated reliability/capability/systems redundancy
Approved landing sites for a generator failure and range limited by battery life.
Engine failure glide range

Landing sites
Four Tech Demonstration Missions

1st Fire Mission
8/16/07
9.5 hours
1400 nmi

2nd Fire Mission
8/29/07
16.1 hours
2500 nmi

3rd Fire Mission
9/7/07
20 hours
3200 nmi

4th Fire Mission
9/27/07
10 hours
1800 nmi
Ikhana Infrared Data and GPS locations are merged with 3-D Google Earth map/image. Transmitted to Fire Fighters in less than 10 minutes (vs. hours).

Ikhana-located hot spots. “...lives and property saved.”

Known Fire line

NASA MQ-9 Ikhana

Ikhana image of Zaca Fire
Santa Barbara, CA, 2007
Questions?