

# Flying Unmanned Aircraft: A Pilot's Perspective

*"It's not un-piloted..."*



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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”



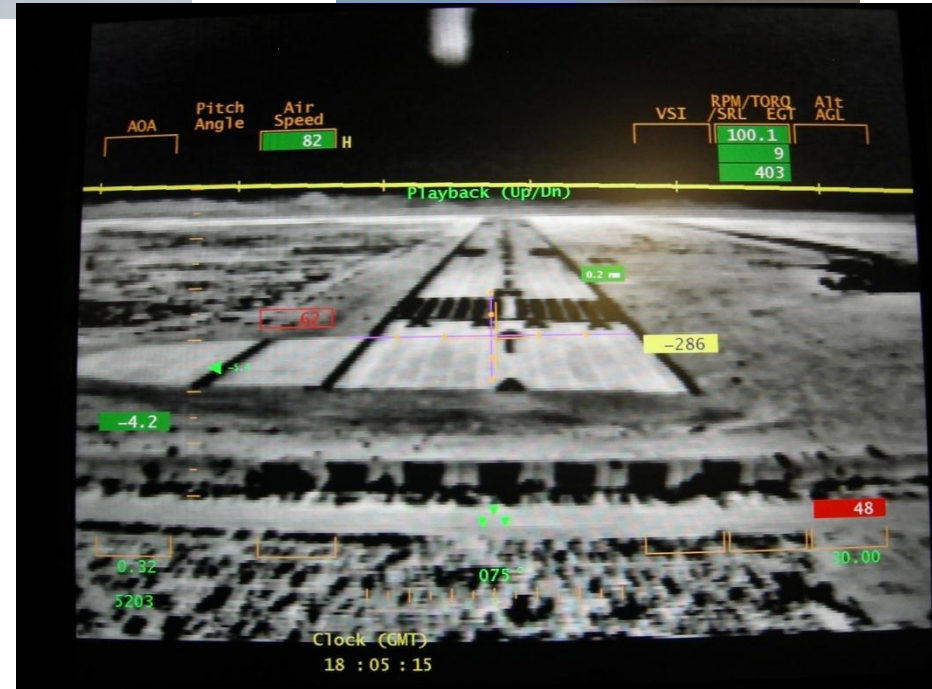
## MQ-9 Reaper/ Predator-B



## 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**



# Ground Control Station

Over The Horizon  
Long Range Link  
Ku-bandSatCom



# MQ-9 Ground Control Station (GCS)

Two Pilot Stations







**Tracker Display  
Systems Menus**

**Camera View with HUD**

**Systems Displays  
Systems Menus**

**Keyboard / Trackball**

**Control Stick,  
Throttle, Flaps, Rudder Pedals**



## Remote Camera

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 30° 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.



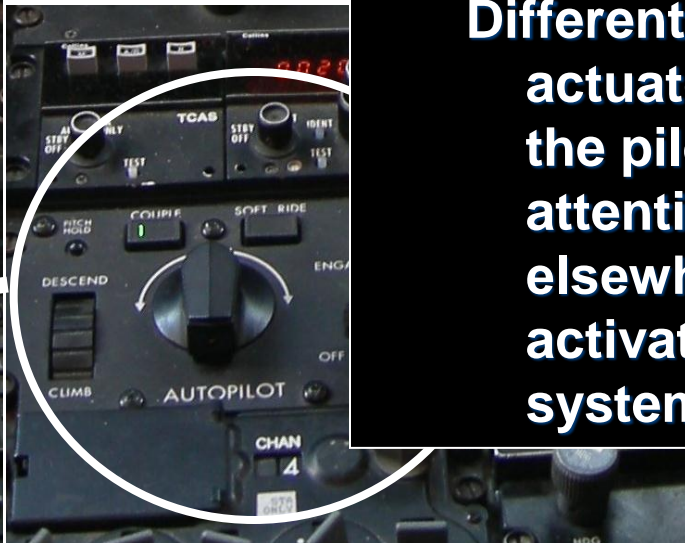
**Cessna 182**



**Boeing 737**



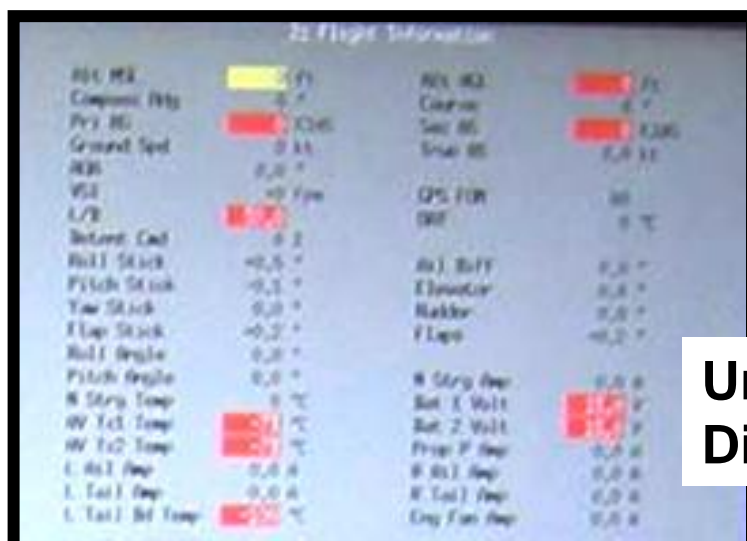
**Use of the Tactile sense**



**Different shapes of actuators enable the pilot to direct attention elsewhere...while activating systems.**



# Digital Information Can be displayed in Analog Format



Unmanned Aircraft System  
Digital /Tabular Display Format

# Example of Display and Control Issues

## IFF Transponder “IDENT” Task

1. Remove right hand from control stick
2. Move cursor 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

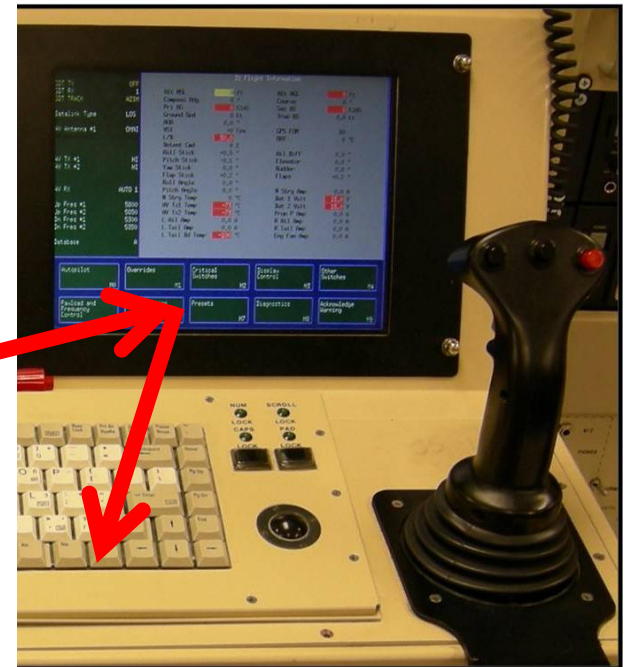


# Example of control / display issues

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"?



TOYSBASE.COM

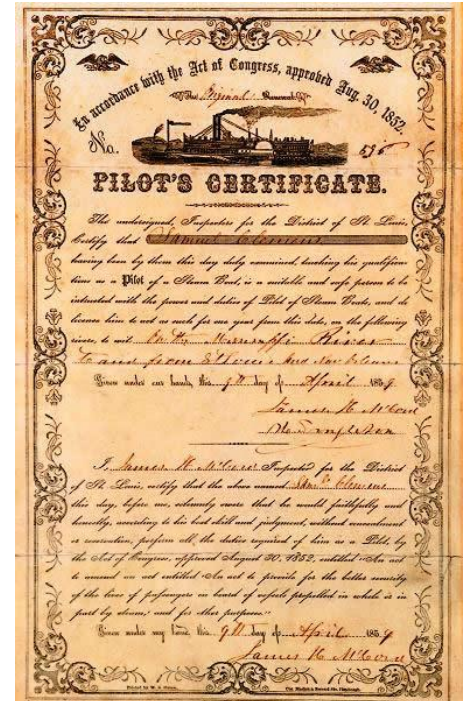


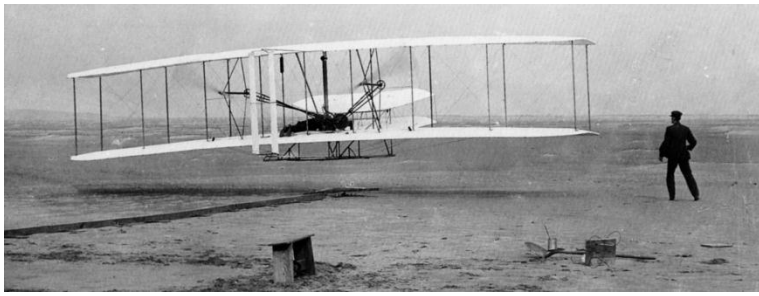


**Samuel Clemens and his Pilot's Certificate**

19<sup>th</sup> Century Pilot.

- Riverboat Captain
- Skills: River navigation, rudder control, soundings, shovel coal, supervisor...





## 20<sup>th</sup> Century Pilot

- Strapped to an airplane, direct interface to controls.
- Motor skills are primary metric of performance
- Increasing use of automation, systems management.





21<sup>st</sup> 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)



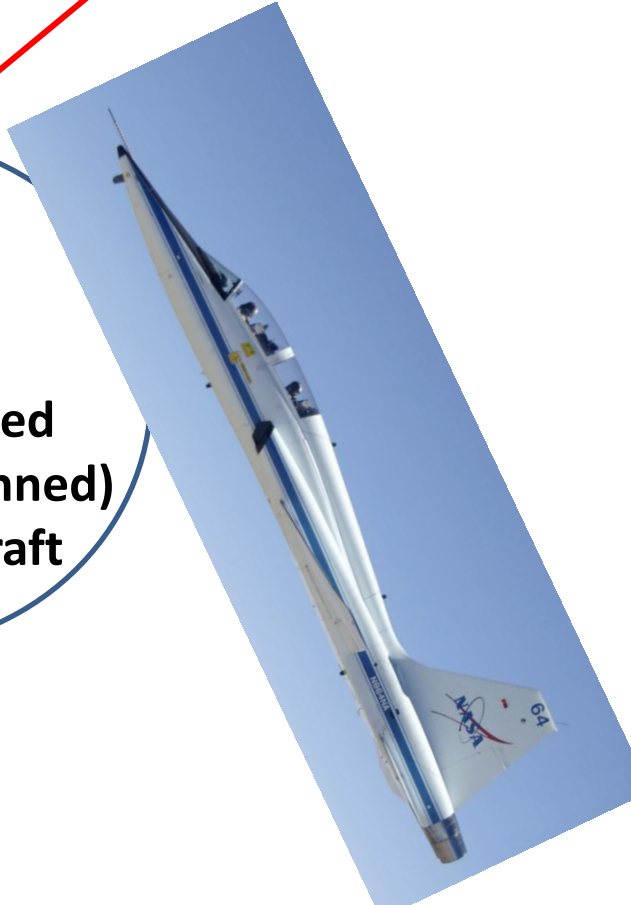
Video Gamer



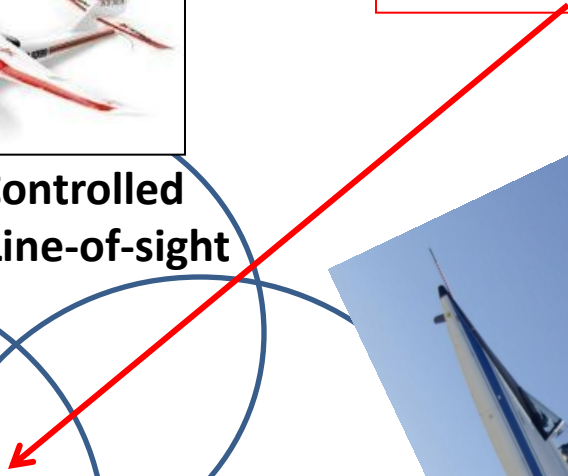
Radio Controlled  
Visual Line-of-sight

Remotely  
Piloted  
Unmanned  
Aircraft  
System

Piloted  
(manned)  
Aircraft



What do these people have in common?



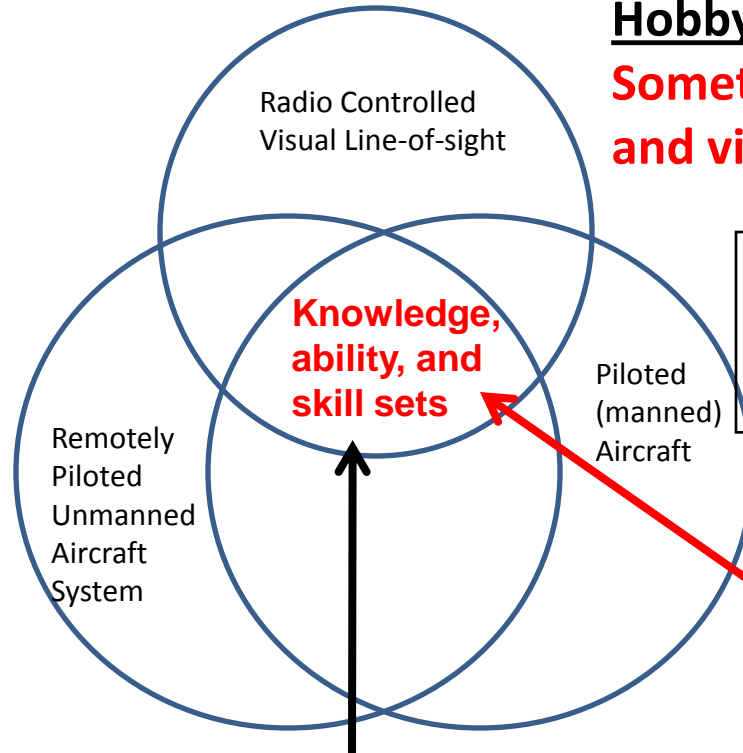
# What is a “pilot” ?

## 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**

**Jet Jock**  
**Self-preservation  
instincts.**

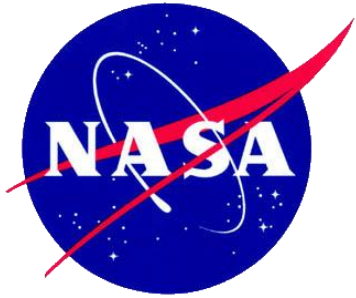
**Plus: Judgment,  
experience,  
flexibility, etc.**

**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”
  - Hence: Training, qualification, currency, proficiency standards depend on the method of control, et al.
- 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

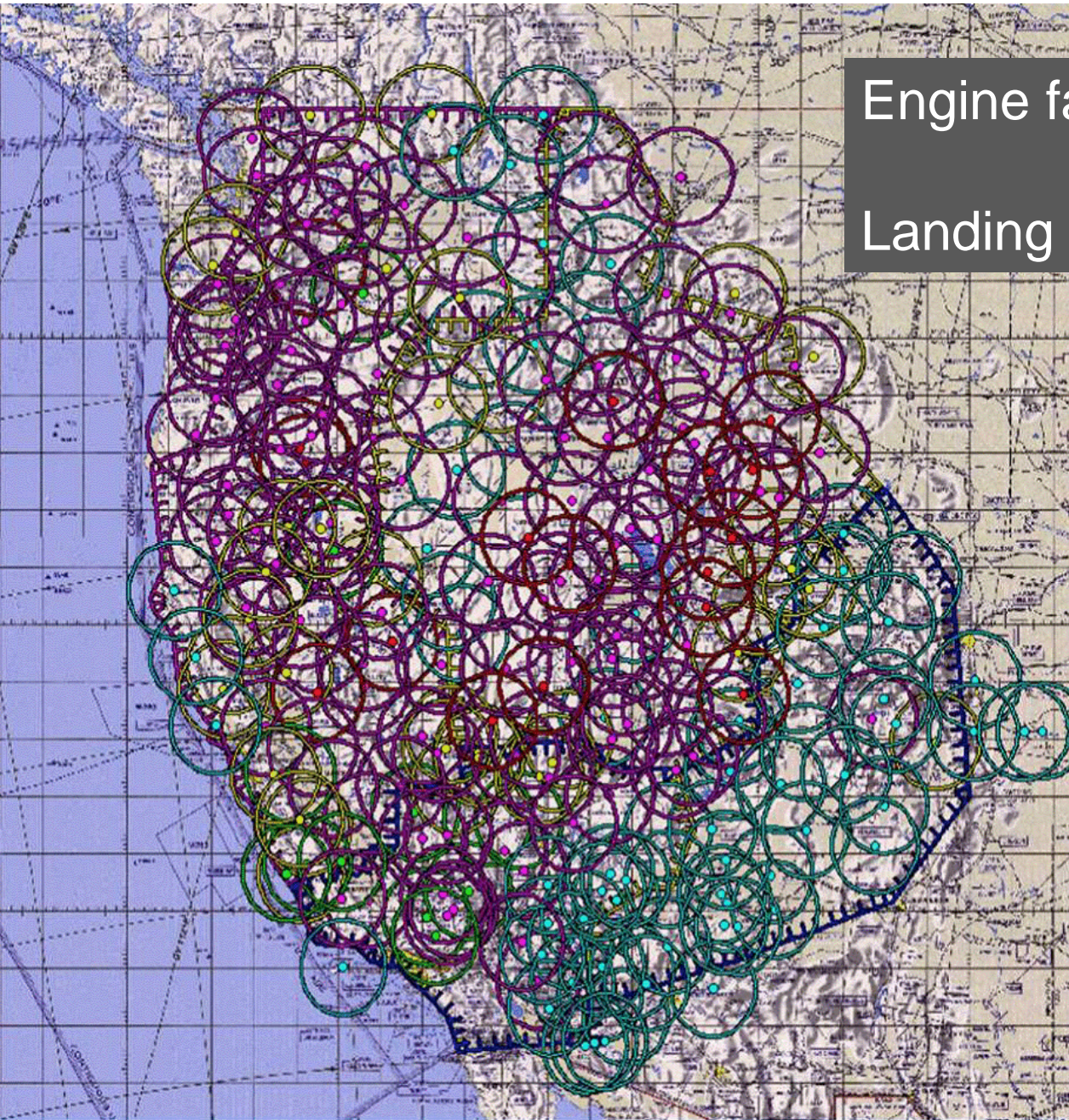
- **One assigned Flight Level (FL 230), in Class A airspace.**
- **-Two-way radio communication and transponder.**
- **- Climbs/descents while in Edwards AFB airspace.**
- **File flight plan 72 hrs prior, fly 1 of 3 “standardized” routes.**
- **Demonstrated “Lost Link” ability: Return via same route.**
- **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



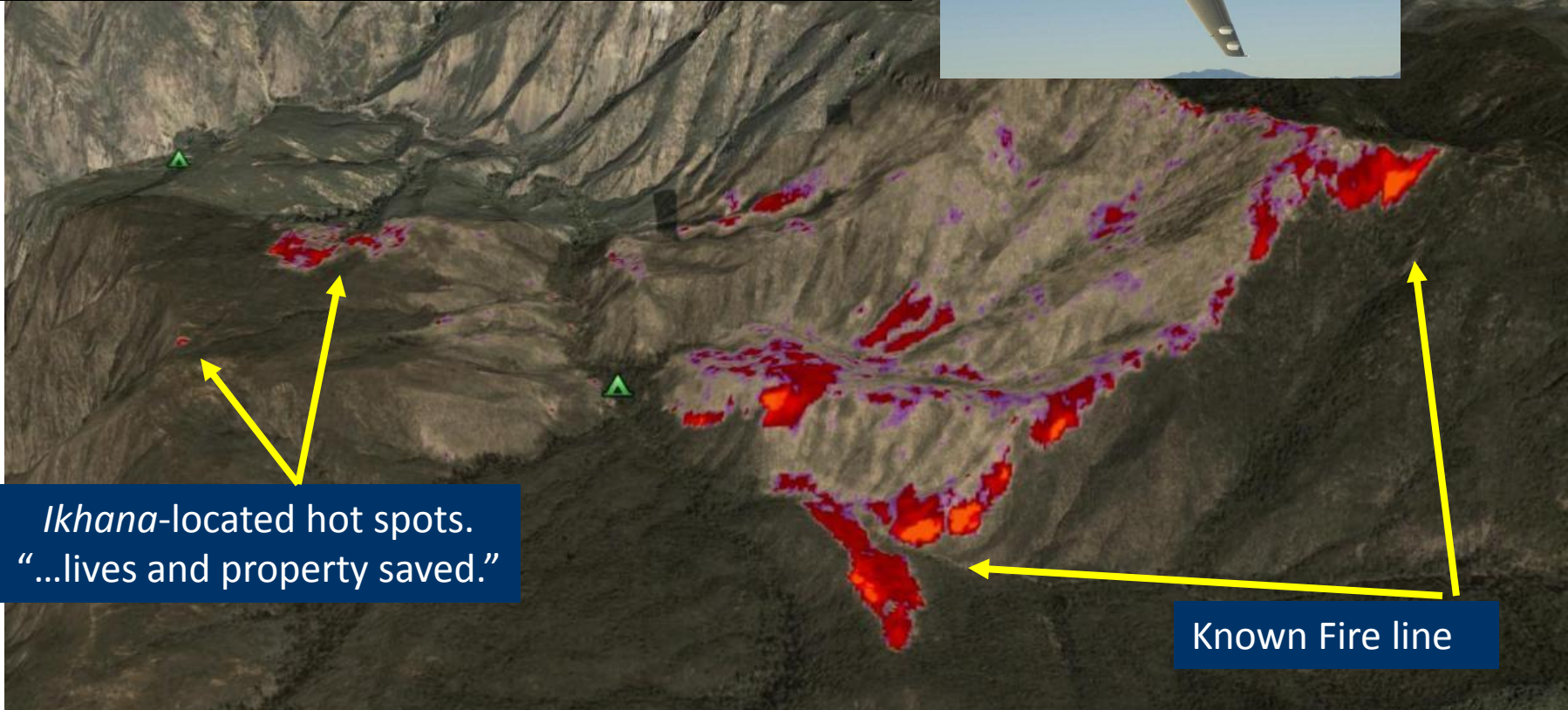
# Four Tech Demonstration Missions



*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).



NASA MQ-9 *Ikhana*



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

Known Fire line

*Ikhana* image of Zaca Fire  
Santa Barbara, CA, 2007



Questions?

