



# Designing Humans for UAVs: An Operator's Perspective

## CERICI Workshop 2004



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- ▶ **Why do we need humans?**
- ▶ **What kind of humans?**
- ▶ **What medical standards for these humans?**
- ▶ **What type of human computer interface (HCI)?**
- ▶ **The Road Ahead**

# Why do we need Humans?

## The Cost

- ▶ Responsibility for multi-million dollar assets

## The Tasking

- ▶ Integration with manned aviation
- ▶ Expanding roles & missions
- ▶ Dynamic re-tasking
- ▶ Life & death decisions in combat

## The Technology

- ▶ Fully autonomous still difficult to achieve
  - ▶ Complex emergencies are handled better by humans



# What kind of humans?

## Rank/Rate/Military Occupational Specialty

- ▶ **Officer vs. enlisted**
  - ▶ **Decision making authority**
- ▶ **Pilot vs. non-flyer**
  - ▶ **Where do you intend to fly?**

## Pre-selection criteria

- ▶ **What kind of written aptitude tests?**
- ▶ **What type of physical examinations?**
- ▶ **What about psychomotor testing?**

**Why are the Services doing it differently?**

**What's the primary factor:  
technology or philosophy?**



# What medical standards for these humans?

## Medical Certification for manned aircraft pilots

- ▶ **Permanently disqualifying**
  - ▶ **Examples: alcoholism, drug addiction, epilepsy, ...**
- ▶ **Temporarily disqualifying**
  - ▶ **Examples: anemia, sinus infections, ulcer, ...**

## Temporary groundings

- ▶ **Illness, alcohol use, fatigue, stress, emotion**
- ▶ **Certain medications**
- ▶ **Use of personal stressor checklists**

**What are the medical standards  
for UAV crews?**



# What kind of Human Computer Interface?

## HCI Goal for UAV Ground Control Station:

- ▶ **Safe, efficient, effective control of the air vehicle**

## Ergonomic Goal: Minimize Physical Fatigue

- ▶ **Form and fit to the human body**
- ▶ **Comfortable environment (temp and lighting)**

## Cognitive Goal: Minimize Mental Fatigue

- ▶ **Digital versus analog displays**
- ▶ **Placement and font of text**
- ▶ **Appropriate symbol shapes and colors**

## Response Goal: Minimize UAV Response time

- ▶ **While preventing over control**
- ▶ **Stick and Rudder vs. Point and Click**



# Sample HCI Design Questions

Does display or control always operate as documented?

- ▶ **Principle:** It should operate in accordance with the documentation and in a way that represents an operator's "intuitive" understanding.

Is this control/display like others in the operator's previous experience?

- ▶ **Principle:** Standardization facilitates learning and transfer of operational skill between various systems. Possible "negative learning transfer" can result if controls are non-standard.

Is this display/control likely to be confused for any other?

- ▶ **Principle:** Controls and displays that have different functions but similar arrangements are potentially hazardous. Display formats must be distinguishable from one another to clearly assess flight status data.

Are instruments and controls with related functions grouped together in a logical arrangement?

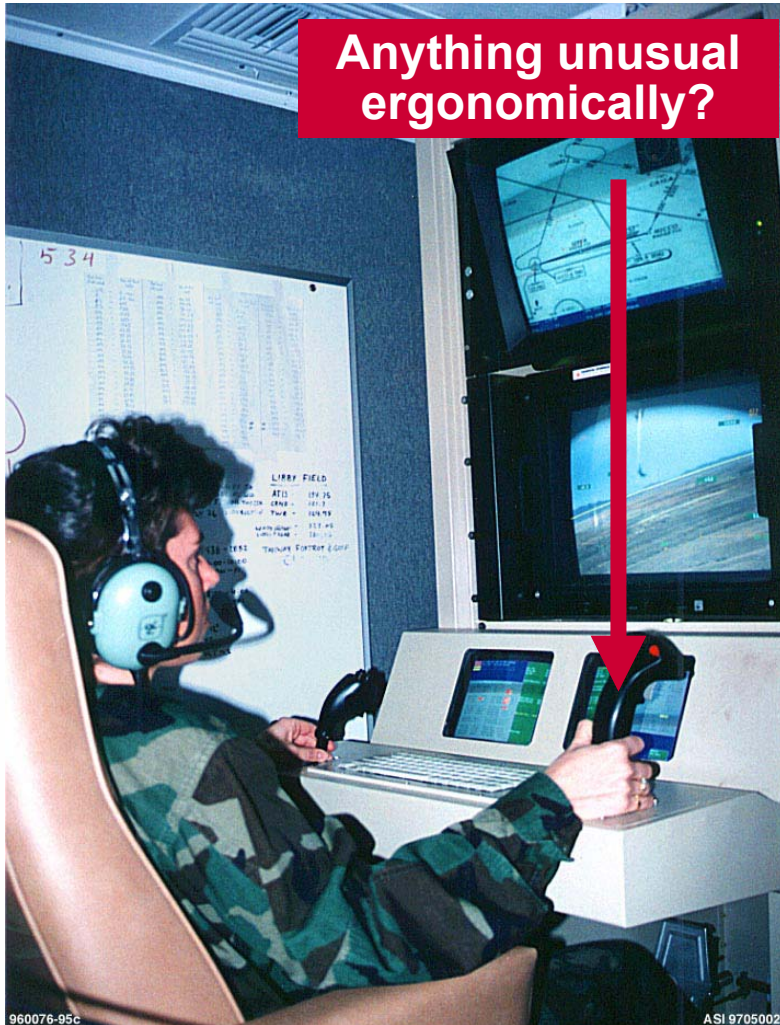
- ▶ **Principle:** logical grouping of controls/displays helps reduce instrument scan time and lowers operator workload.

Adapted From: "Cockpit Control and Display Design Hazard Analysis"

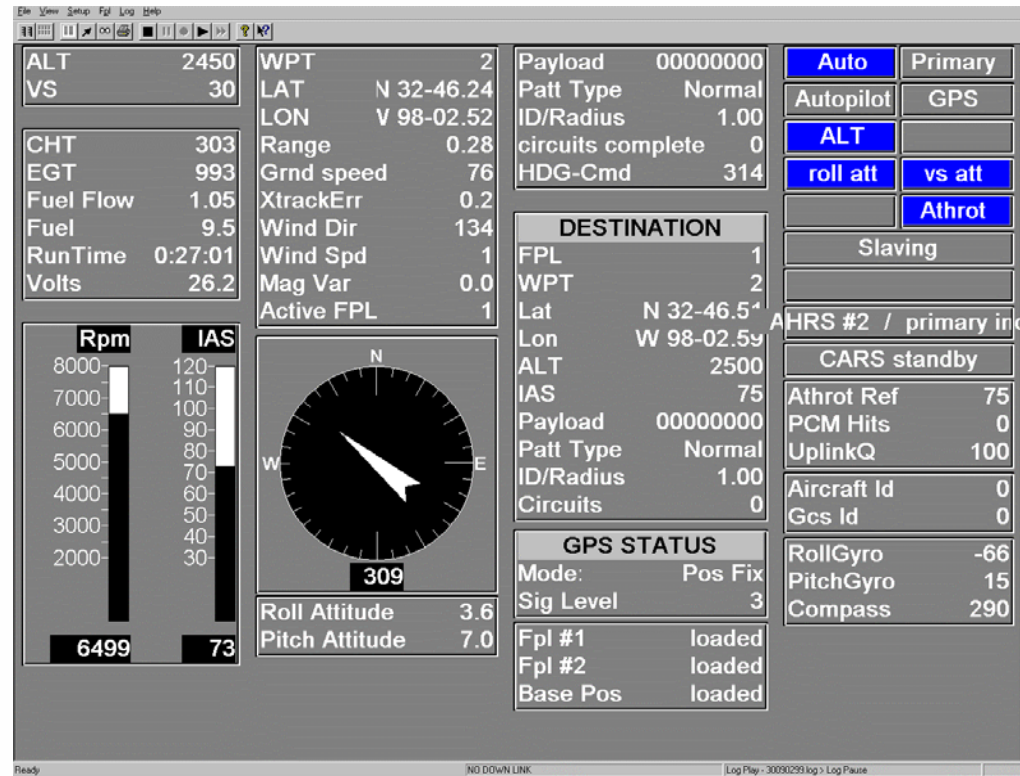
Author: Anthony Ciavarelli, Ed. D.



# HCI Examples



**Stick and Rudder HCI**



**Point and Click HCI**

- Which is the better interface?  
- How should we define "better?"  
- Has anyone done a proper study?



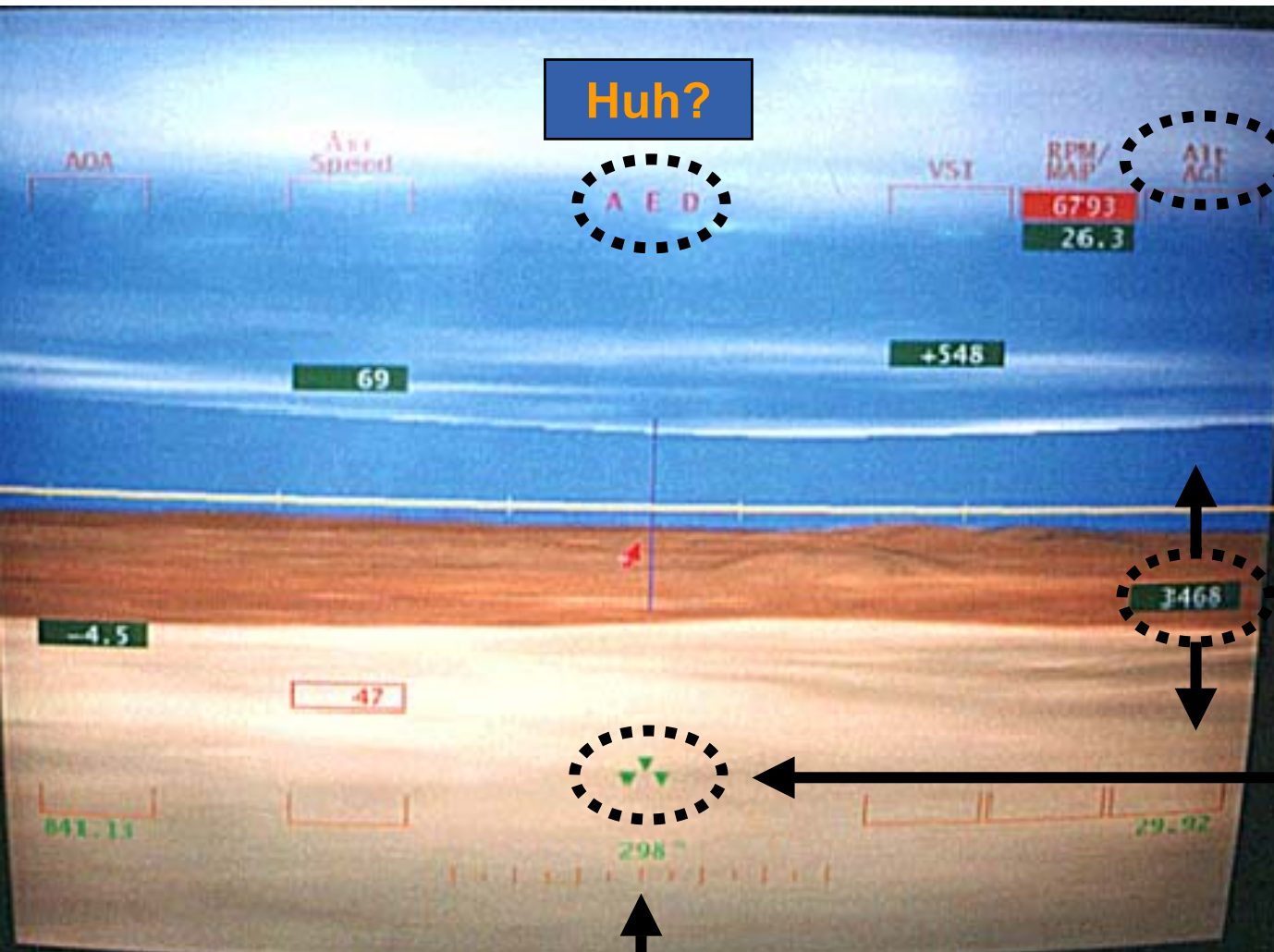
# Chromostereopsis

Different wavelengths of light focus at different distances from the retina.

Can you read this?

How about this?

# Some More Examples: UAV HUD



Chromostereopsis

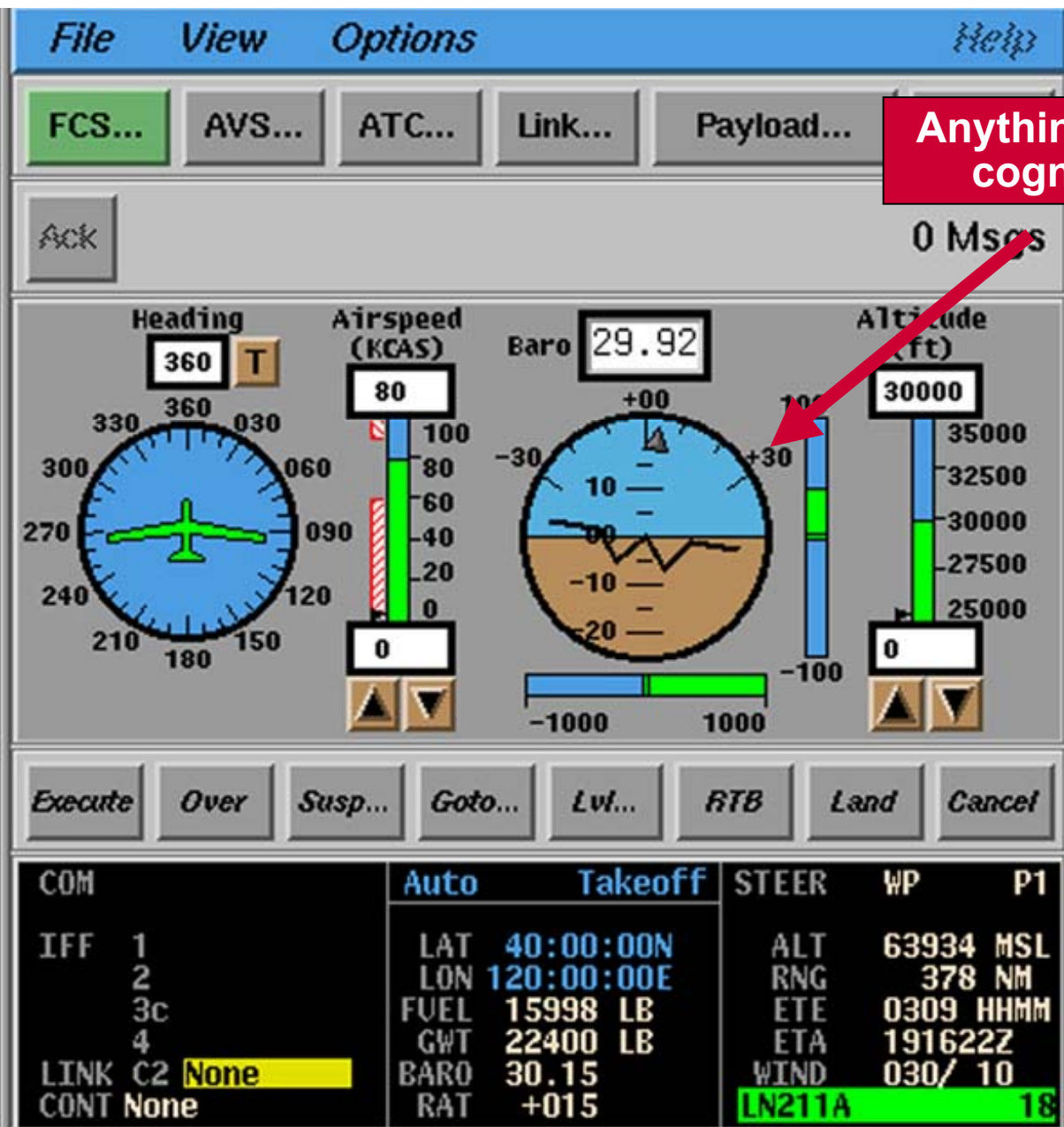
Sliding Bar

Use of Symbols

Use of Scale



# Even More Examples: UAV Instrument Panel



Anything unusual cognitively?

Poor design can lead to control action errors

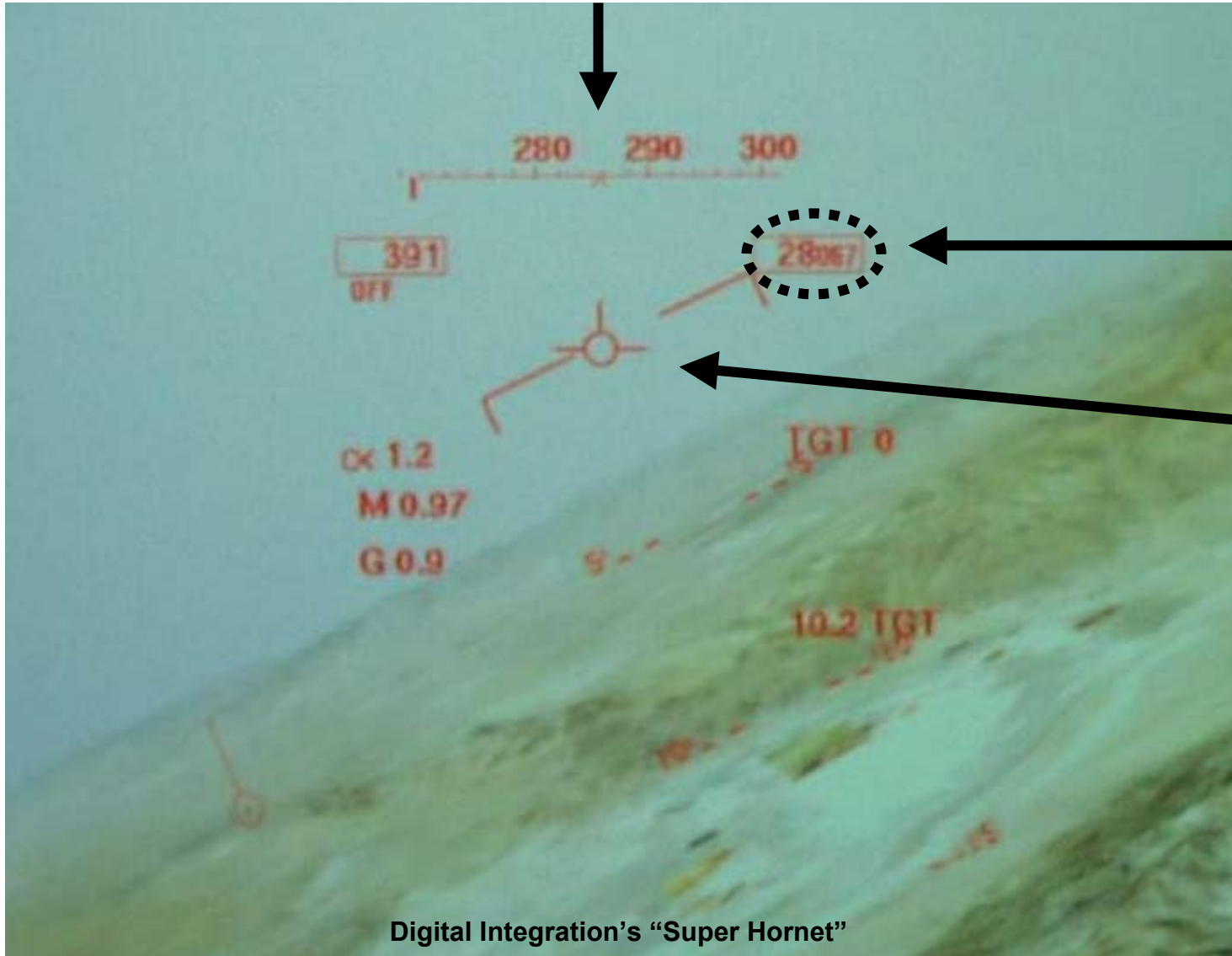
- ▶ Reversal errors
- ▶ Precision errors

Due to

- ▶ Habituation
- ▶ Negative learning transfer

# Comparison to Manned Aircraft HUD

Use of Scale



Fixed  
location

Horizon  
Line



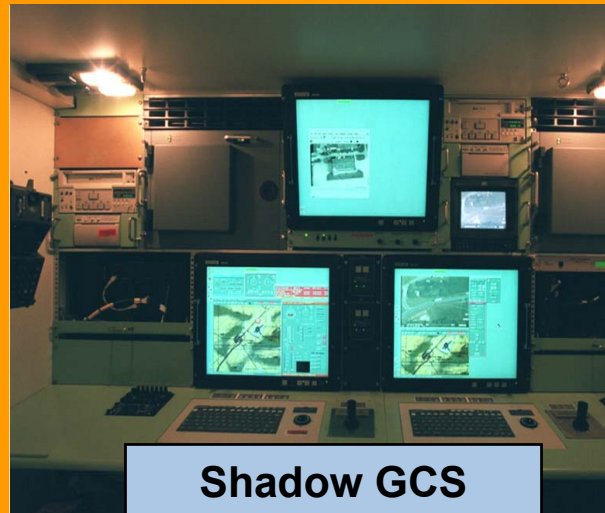
# HCI Affects Manning/Training/Safety



**Pioneer GCS**

- ▶ Unique stick & rudder consoles
- ▶ Commands from each are combined
- ▶ Only one console affects flight safety
- ▶ Therefore, skillsets are console dependent

Crew = 3: AVO + PO + MC



**Shadow GCS**

- ▶ Identical point & click consoles
- ▶ Commands from each are combined
- ▶ Both consoles affect flight safety
- ▶ Therefore, two identical skillsets required

Crew = 2: AVO/PO x 2



**Hermes GCS**

- ▶ Identical point & click consoles
- ▶ Commands from each are NOT combined
- ▶ Only one console affects flight safety
- ▶ Therefore, skillsets are console dependent

Crew = 2: AVO/PO + MC

# I Swear I'm Not Making These Up

**Pioneer into the trees**

- ▶ **Depth Perception**

**Pioneer student pilot washout**

- ▶ **Farming accident**

**Pioneer inadvertent spin**

- ▶ **Who recovered it?**

**Global Hawk spin**

- ▶ **Impact of point & click HCI**



# Summary / Road Ahead

There will always be a place for humans in unmanned aviation.

The UAV community needs to define:

- ▶ How will they be selected?
- ▶ What standards must they adhere to?
- ▶ What training must be provided?
- ▶ What HCI will they interact with?

Formal studies are required

On the right track

- ▶ U.S. Army Regulation 95-23, UAV Flight Regulations
- ▶ ASTM International F38.03
  - ▶ Subcommittee on UAV Operator Standards

Key Resource

- ▶ U.S. Navy School of Aviation Safety
  - ▶ <http://avsafety.nps.navy.mil>
  - ▶ Human Factors Checklists, etc.



# Some Good News

**“The use of connectors of similar size and configuration adjacent to each other should be avoided. If such conditions cannot be avoided, the connectors shall be keyed in such a manner as to prevent wrongful connection.”**

- ▶ **From Army draft ERMP UAV Technical Requirements Document**

**“The BAMS UAV System functional and design specifications affecting human systems interactions shall make ample allowance for the capabilities and limitations of the typical, qualified person or team of personnel, consistent with relevant, validated, and documented models of individual and collective human performance.**

- ▶ **From Navy draft BAMS Document**

