



rf9kdg.mpg



Human Factors of Unmanned Aviation: CERI 2006



Cognitive Engineering
Research Institute
for Collaborative Innovation



bai
brandes associates inc.
Jeff Goldfinger

775-428-6877
jgoldfinger@brandes-assoc.com

Outline

- ▶ Where we were in 2004
 - ▶ What kind of humans?
 - ▶ What kind of human computer interface?
- ▶ Where are we now?
 - ▶ Some positive signposts
- ▶ What should we be doing?

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

- ▶ **Written aptitude tests**
- ▶ **Physical examinations**
- ▶ **Psychomotor Testing**

Why are they all doing it differently?

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



What kind of Human Computer Interface?

HCI Goal: Safe, efficient, effective control of the air vehicle

Ergonomic Issues : Minimize Physical Fatigue

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

Cognitive Issues : Minimize Mental Fatigue

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

Responsiveness Issues : Minimize UAV Response time

- ▶ **Rapid response while preventing over control**
- ▶ **Stick and Rudder vs. Point and Click**



Ergonomic Examples



Anything unusual?

System X's GCS

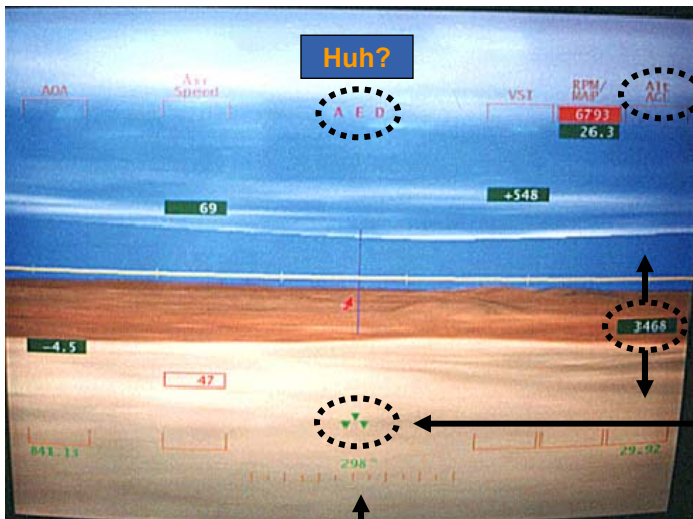


Notice Support Pads

Elbit Systems' GCS



Cognitive Example: Heads-up Display



Use of Scale

Chromostereopsis

Sliding Bar

Use of Symbols



Cognitive Example: Instrument Panel

Anything unusual?

- ▶ Manned Aircraft:
 - ▶ ±180° of roll
- ▶ This UAV:
 - ▶ ±30° of roll
 - ▶ But scale is off
 - ▶ 30° ≠ 60°
- ▶ Manned Aircraft:
 - ▶ Fixed horizon line
 - ▶ Rotating sphere
- ▶ This UAV:
 - ▶ Fixed sphere
 - ▶ Rotating horizon line

7 CERL2006

Responsiveness Examples

Stick and Rudder

Point and Click

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

8 CERL2006

What not to do!

- ✗ Inadequate hazard advisory or warning display
- ✗ Nonstandard cockpit layouts
- ✗ Excess operational mode complexity
- ✗ Hard to read instrument data (legibility, glare, lighting)
- ✗ Control/displays outside vision/reach envelope
- ✗ Incompatible aircraft response mapping

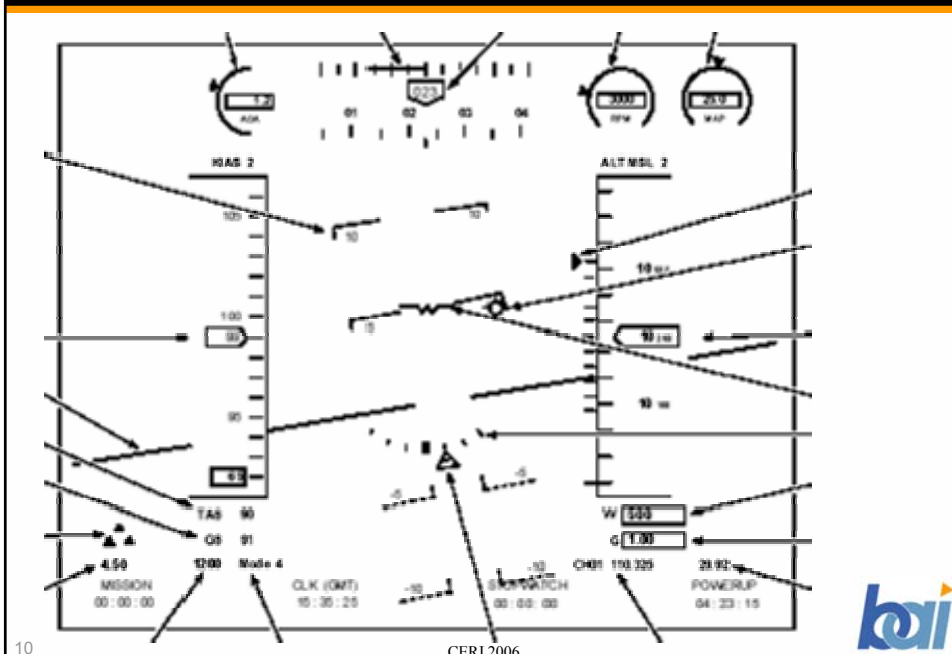
Often leads to design-induced aircrew errors.

From: School of Aviation Safety
Human Factors Checklist
Authors: Anthony Ciavarelli, Ed.D.
Thomas E. Sather, M.S., M.S.S.

9

CERL2006

Positive Signpost: Mil-Std UAV HUD



10

CERL2006



Positive Signposts (cont.)

Performance Specification for the CBP UAV System

- ▶ "... shall not cause any adverse effects on the operators or maintainers."
- ▶ "... and the operator's stations designed to minimize inadvertent operator encounters with edges, shelves, and other station protuberances."
- ▶ "... an acoustical environment which should not cause personnel injury, ... cause fatigue, or in any other way degrade system effectiveness."
- ▶ STANAG 4586 compliant

Charter of a UAV for OPERATION ARCHER

- ▶ "The GCS shall have environmental controls to protect the crew and equipment in the environment (i.e. filters, heater, air conditioning)."
- ▶ STANAG 4586 compliant

USMC Tier II UAV System (Draft)

- ▶ Cites 81521B Training Program Structure Document
- ▶ STANAG 4586 compliant



Positive Signposts (cont.)

Draft Navy BAMS 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."

Army ERMP UAV Technical Requirements Document

- ▶ "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."

L-3Comm/Link Simulation & Training PMATS Award

- ▶ The value of a true virtual environment
- ▶ Winner's pedigree as a training company



Positive Signposts (cont.)

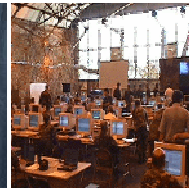
Workshop

Human Factors of Unmanned Aerial Vehicles



"Manning the Unmanned"

Cognitive Engineering
Research Institute
for Collaborative Innovation



13

CERI2006

Positive Signpost (cont.)

RFI: Unmanned Air System Operator Workload Reduction -
NDN- 227-0072-7894-7 PUBLICATION DATE- 2006-05-22

Description: NAVAIR is seeking innovative technology concepts to **reduce UAS operator workload** ... to better manage and control multiple dissimilar Navy [UA and their] associated payloads. Various studies and assessments of UAS operator activities **have determined that effective control of multiple unmanned vehicles taxes an individual's visual, audio, and cognitive skills**. The objectives of this RFI are to:

1. Identify technologies that ... can be seamlessly integrated...
2. Refine identified technologies [for] Navy UAS... missions.
3. Demonstrate that the technologies will reduce operator workload.
4. Increase the quantity of **control from two to as many as eight**.



14

CERI2006

Some HCI Design Principles

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.



15

The Road Ahead

There will always be a place for hu-mans in un-manned 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

- ▶ Will assist with FAA/CAA certification issues

Many positive signposts

- ▶ Would like to see more
- ▶ Hire an experimental psychologist today!!!!



16

CFR12006