Pilot Aircraft Interface Objectives/ Rationale

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Meeting of Experts on NASA's Unmanned Aircraft System (UAS) Integration in the National Airspace Systems (NAS) Project

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Pilot Aircraft Interface Issues

- UAS Pilot/Operator
    - **Loss of senses**
        - Audition
        - Vestibular Cues
        - Olfactory
        - Monocular vision & reduced FOV (e.g., 30 degrees)
- Long duration missions
- Crew handovers
- No standard requirements/training
    - USAF - rated pilots
    - Army - specially trained soldiers
    - Raven operators - one week of training

Pilot Aircraft Interface Issues

- Ground Stations
  - **Lack of standardization**
  - **Lack of application of 70+ years manned cockpit experience**
  - **Huge disparity in level of automation & proposed use of NAS**
    - Raven, Predator, Shadow, Global Hawk
  - **Rush to service**
    - Advanced Concepts Technology Demonstrations
    - Engineering displays became operational
      - **Improved GCS efforts are underway**
  - **Proprietary**
  - **Generally not built with eye toward NAS**
  - **UAS specific issues**
    - Delays
    - Loss of link
    - Contingency operations
    - Link strength/Type
    - Data-link Frequency Use
    - Vehicle Speed/maneuverability (pilots and ATC)
    - Shifting human-automation functional allocation (particularly for SA/CA & landings)

Scope

In scope:

- NASA will address those issues related to UAS integration into the NAS – based on information requirements analysis

- Develop guidelines for a UAS/GCS to operate in the NAS/ Demonstrate proof of concept

- Generic PAI issues (e.g., operator FOV) when needed to effectively test UAS-NAS integration

Out of scope:

- Determination of pilot v. non-pilot qualifications for UAS operation

Scope

	Primary*
	Support

Class of UAS User Interaction	Airspace Req'd	Cap/ Req
Small (Raven) R/C, Portable	G (2k), TFR	Ground based ?
Mid-Size (Shadow) Semi-Auto, Mobile	E (10k)	Sense & Avoid, Traffic
Large (Predator) Manual, Fixed	A (18-45k)	Sense & Avoid, Traffic
Large (Global Hawk) Auto, Fixed	A, E (18-60k)	Sense & Avoid, Traffic

* Employed by DHS, USAF, Army

Pilot Aircraft Interface Definitions

- PAI – Pilot Aircraft Interface (includes visual, auditory, tactile displays and controls)

- GCS – Ground Control Station

- SA – Situation Awareness = sum of informational elements aggregated in context sensitive nodes weighted by importance

- Workload – Effort expended to perform the required task (NASA-TLX, Secondary tasks)

- UAS Pilot/operator – "Controller" of UAS

- Full Mission Simulation – High fidelity, integrated with ATC sim, SA/CA

PAI Objectives

- **Objective: Database and proof of concept for guidelines for GCS compliance**
  - *Rationale*:
    - Provide research test-bed to develop guidelines
    - Modify GCS for NAS Compliance to provide proof of concept
  - *Approach*:
    - Assess current state of GCS technology
    - Information Requirements Definition
    - SME Workshop
    - Modify an Existing GCS for NAS Compliance
    - Define exemplar UAS (choose system to develop prototype)
    - Define Candidate Displays & Controls
    - Evaluate/ refine in Simulations
    - Demonstrate in flight
  - *Deliverables:*
    - Information Requirements Report
    - Workshop Proceedings
    - Technical Reports/ papers on Simulations & Flight Demo
    - Database for guidelines

Database and proof of concept for guidelines for GCS compliance

FY	Deliverable	To	Used For
	Phase I		
11	Proceedings of UAS In the NAS HF Workshop	DoD, tech elements, Industry	Req't's & Sim
11	Info Requirements	DoD, Industry	Guidelines and sims
	Phase II		
12	Candidate PAI Suite	DoD, Industry	PAI refinement
14	Full Mission Simulation	DoD, Industry	+ Guidelines
15	Integrated Flight Demo	DoD, Industry	Proof of concept

PAI Objectives

- **Objective: Develop Human Factors Guidelines for GCS Operation in the NAS**
  - *Rationale*:
    - Provide guidelines for GCS integration into the NAS
    - Encourage standardization of primary flight displays (especially with respect to operation in the NAS)
    - Publish in conjunction with standards organization
  - *Approach*:
    - Define Scope/Issues
    - Identify on-going efforts (military, foreign)
    - Identify appropriate standards organization
    - Develop guidelines for exemplar UAS
    - Develop guidelines for remaining classes of UAS
  - *Deliverables:*
    - Technical Reports
    - Guidelines

Develop Human Factors Standards/Guidelines for GCS Operation in the NAS

FY	Deliverable	To	Used For
12	Phase I Guidelines for 1st Category of UAS	Std. Org, DoD, Industry	Compliance and basis for additional classes
13	Phase II Draft Guidelines for 2nd/3rd Category of UAS	Std. Org, DoD, Industry	Comment/Review
14	Final Document	Std. Org, DoD, Industry	Guidelines for Compliance

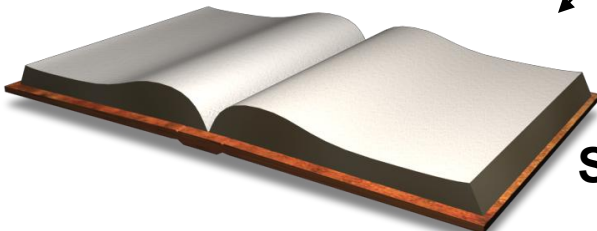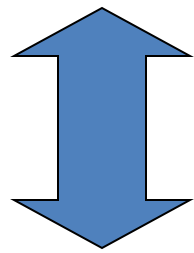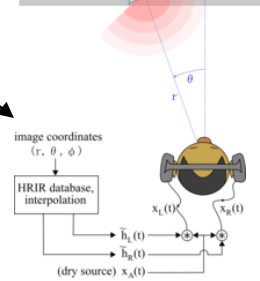# *Notional* Vision

4D Separation
Tools

Tactile
Displays

Spatial
Audio
Warning

Traffic on
Tactical Sit.
Display (TSD)

Integrated
Into caution,
warning, advisory

Supervisory
Control/ Level
Of Automation

**UAS
Industry**

Guidelines

SAE, RTCA

Initial Partnering Effort: Workshop

- Objectives:
  1. **Hold workshop to identify critical Human Factors issues related to operation of UAS in the NAS from the perspective of researcher, stakeholders (e.g. DHS, DoD), and users (i.e. UAS operators/pilots) [Day 1&2].**
  2. **Review and receive feedback on current PAI plan to ensure key areas are being addressed [Day 2].**
- Attendees
  - **UAS Human Factors Researchers:**
    - AFRL, Navy, BYU, MIT, ASU, Texas A&M, U of Illinois, OSU
  - **Representatives from Stakeholders from:**
    - Air Force, Army, Navy, FAA, and DHS
  - **UAS Operators/Pilots**
- Deliverable
  - **Workshop Proceedings: documenting the efforts undertaken for this program and other efforts in the area of UAS human factors. Can serve as input to a larger Roadmap for UAS integration into the NAS**

Facilities

- Multi-UAV Simulation (MUSIM) – Ames
- Air Traffic Control Lab – Ames
- Universal Ground Control Station – Dryden
- Flight Deck Display Research Lab – Ames
- Air Traffic Operations Lab - Langley
- Operational AIRSTAR GCS – Langley
- IDEAS Lab – Langley
- Small UAS aircraft and operations labs – Ames, Langley, Dryden
- Manned surrogate UAS – Langley
- Ikhana MQ-9 - Dryden