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’ts & 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

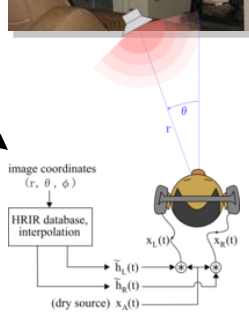
FY	Deliverable	To	Used For
	Phase I		
12	Guidelines for 1st Category of UAS	Std. Org, DoD, Industry	Compliance and basis for additional classes
	Phase II		
13	Draft Guidelines for 2nd/3rd Category of UAS	Std. Org, DoD, Industry	Comment/Review
14	Final Document	Std. Org, DoD, Industry	Guidelines for Compliance

Notional Vision

4D Separation Tools

Tactile Displays

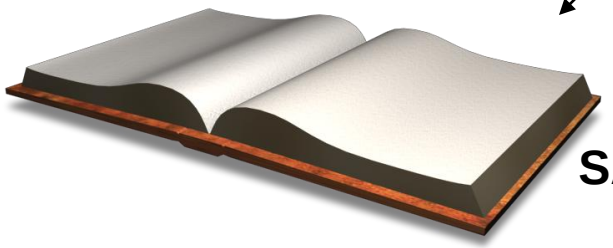
Spatial Audio Warning



Traffic on Tactical Sit. Display (TSD)

Integrated Into caution, warning, advisory

Supervisory Control/ Level Of Automation



Guidelines

SAE, RTCA

U.S. AIR FORCE

UAS Industry

U.S.ARMY

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