Pilot Aircraft Interface
Objectives/Rationale

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Pilot Aircraft Interface Technical Area Lead

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

Aeronautics and Space Engineering Board
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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)
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

<table>
<thead>
<tr>
<th>Class of UAS</th>
<th>Airspace Req’d</th>
<th>Cap/ Req</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small (Raven)</td>
<td>G (2k), TFR</td>
<td>Ground based ?</td>
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<tr>
<td>R/C, Portable</td>
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<tr>
<td>Mid-Size (Shadow)</td>
<td>E (10k)</td>
<td>Sense &amp; Avoid, Traffic</td>
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<td>Semi-Auto, Mobile</td>
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<tr>
<td>Large (Predator)</td>
<td>A (18-45k)</td>
<td>Sense &amp; Avoid, Traffic</td>
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<td>Manual, Fixed</td>
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<td>Large (Global Hawk)</td>
<td>A, E (18-60k)</td>
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* 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
<table>
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<tr>
<th>FY</th>
<th>Deliverable</th>
<th>To</th>
<th>Used For</th>
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<tr>
<td></td>
<td>Phase I</td>
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<tr>
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<td>Proceedings of UAS In the NAS HF Workshop</td>
<td>DoD, tech elements, Industry</td>
<td>Req’ts &amp; Sim</td>
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<td>Info Requirements</td>
<td>Industry</td>
<td>Guidelines and sims</td>
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<td>Candidate PAI Suite</td>
<td>DoD, Industry</td>
<td>PAI refinement</td>
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<tr>
<td>14</td>
<td>Full Mission Simulation</td>
<td>DoD, Industry</td>
<td>+ Guidelines</td>
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<tr>
<td>15</td>
<td>Integrated Flight Demo</td>
<td>DoD, Industry</td>
<td>Proof of concept</td>
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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
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<th>Used For</th>
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<tr>
<td>12</td>
<td>Phase I</td>
<td>Std. Org, DoD, Industry</td>
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<td>Final Document</td>
<td>Std. Org, DoD, Industry</td>
<td>Guidelines for Compliance</td>
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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

UAS Industry
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