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)
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><strong>Small (Raven)</strong></td>
<td>G (2k), TFR</td>
<td>Ground based ?</td>
</tr>
<tr>
<td>R/C, Portable</td>
<td></td>
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<tr>
<td><strong>Mid-Size (Shadow)</strong></td>
<td>E (10k)</td>
<td>Sense &amp; Avoid, Traffic</td>
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<tr>
<td>Semi-Auto, Mobile</td>
<td></td>
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<tr>
<td><strong>Large (Predator)</strong></td>
<td>A (18-45k)</td>
<td>Sense &amp; Avoid, Traffic</td>
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<tr>
<td>Manual, Fixed</td>
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<td></td>
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<tr>
<td><strong>Large (Global Hawk)</strong></td>
<td>A, E (18-60k)</td>
<td>Sense &amp; Avoid, Traffic</td>
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<tr>
<td>Auto, Fixed</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
Database and proof of concept for guidelines for GCS compliance

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<tr>
<th>FY</th>
<th>Deliverable</th>
<th>To</th>
<th>Used For</th>
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<tbody>
<tr>
<td></td>
<td>Phase I</td>
<td></td>
<td></td>
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<tr>
<td>11</td>
<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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<tr>
<td>11</td>
<td>Info Requirements</td>
<td>DoD, Industry</td>
<td>Guidelines and sims</td>
</tr>
<tr>
<td></td>
<td>Phase II</td>
<td></td>
<td></td>
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<tr>
<td>12</td>
<td>Candidate PAI Suite</td>
<td>DoD, Industry</td>
<td>PAI refinement</td>
</tr>
<tr>
<td>14</td>
<td>Full Mission Simulation</td>
<td>DoD, Industry</td>
<td>+ Guidelines</td>
</tr>
<tr>
<td>15</td>
<td>Integrated Flight Demo</td>
<td>DoD, Industry</td>
<td>Proof of concept</td>
</tr>
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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

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<tr>
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<th>Used For</th>
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<tbody>
<tr>
<td>12</td>
<td>Phase I</td>
<td>Std. Org, DoD, Industry</td>
<td>Compliance and basis for additional classes</td>
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<tr>
<td></td>
<td>Guidelines for 1st Category of UAS</td>
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<tr>
<td>13</td>
<td>Phase II</td>
<td>Std. Org, DoD, Industry</td>
<td>Comment/Review</td>
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<tr>
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<td>Draft Guidelines for 2nd/3rd Category of UAS</td>
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<tr>
<td>14</td>
<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