Unmanned Aircraft Systems (UAS) Traffic Management (UTM) Project

Studying human-system interaction within the UTM system

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UTM Technical Interchange Meeting
February 23rd, 2021
Outline

• Technical Capability Level (TCL) and Risk Association
• TCL and Human Systems Integration (HSI) Considerations
• Demonstration Parameters
• Human Factors (HF) Data Collected across the UTM Project
• Flight Test Demonstration – Summary
• General HSI Findings
  • Information quantity
  • Using information
  • Increasing complexity
  • Standardization
• UTM as a Human-Automation System
## Technical Capability Level (TCL) and Risk Association

### TCL 1
- Remote Population
- Low Traffic Density
- Rural Applications
- Multiple VLOS Operations
- Notification-based Operations

### TCL 2
- Sparse Population
- Moderate-Low Traffic Density
- Rural / Industrial Applications
- Multiple BVLOS Operations
- Tracking and Operational Procedures

### TCL 3
- Moderate Population
- Moderate Traffic Density
- Suburban Applications
- Manned/Unmanned BVLOS Operations
- Detect and Avoid Public Safety Operations

### TCL 4
- Dense Population
- High Traffic Density
- Urban Applications
- Dense Urban BVLOS Operations
- Large Scale Contingency Management

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**Increasing risk**

**Increasing capability**
TCL and HSI Considerations

**TCL 1**
- Simple interface
- Few functions
- Developer-user
- Pre-plan whole area
- Simple questions & observations

**TCL 2**
- Simple interface
- Few functions
- Developer-user
- Pre-plan own flight
- Simple questions & observations

**TCL 3**
- More complex interface
- Many functions
- Crew member
- Pre-plan own flight
- Detailed questions

**TCL 4**
- More complex interface
- Many functions
- Crew member
- Pre-plan own flight
- Detailed questions
### Demonstration Parameters

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<th>Flight Demonstration Details</th>
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<th>Test 3</th>
<th>Test 4</th>
<th>Test 5</th>
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Flight Test Demonstrations - Summary

• Successful demonstration that UTM is a viable method for communication and coordination between sUAS operations

• Successful demonstration of:
  – Data exchange through the system, bringing information from one party to another for situation awareness
  – sUAS enacting contingency maneuvers, showing alerting and demonstrating what information would be needed for real time decision making
  – Complex operations, e.g., multiple, altitude-stratified operations, that gave us a window into the types of procedures crews needed to have in place
• In earlier tests
  • Details missing in UTM information that made it more difficult for crews to establish situation awareness (SA)
• In later tests
  • USS interfaces matured and much more detailed information was available for broader SA

Mean situation awareness responses


Response scale was 1 to 7, extended in chart to show standard deviations
General HSI findings – Using Information

Efficiency of USS interaction

- In earlier tests
  - Less information (& more external planning) in UTM made crew decision making more straightforward

- In later tests
  - USS interfaces matured and more detailed information was available, but it was needed more quickly

Response scale was 1 to 7, extended in chart to show standard deviations
• In later tests
  • Clutter
  • More complex environments required more information to be presented
  • Too many messages for crew to read
  • Message labels not informative for crew

Clarity of information

Response scale was 1 to 7
General HSI Findings – Standardization

- Unfamiliar terminology
  - Information was hard for some users to interpret

- Measurement consistency
  - Use of different units required crews to manually resolve issues

- Undefined procedures
  - UAS an infant industry – no standard approaches to guide the users
  - Too little time for users to make complex contingency decisions

**Mean confidence responses**

- **Very low** 1
- **Very high** 8

Response scale was 1 to 7, extended in chart to show standard deviations.
UTM as a Human-Automation System

• While the end-state of the system is fully automated, the interim nearer-term states will still require manual interaction

• Challenges for near-term usage:
  – Designing displays that are easily usable in a TCL4 environment
    • E.g., Messages that are filtered by criticality
  – Creating UTM training for users

• Challenges for mid-term usage:
  – Automating functions in a manner that keeps remaining manual tasks as coherent activities
Summary and Future Work

• Successful demonstration that UTM is a viable method for communication and coordination between sUAS operations

• But also, to provide enough information to operators for them to have awareness and coordinate actions

• Future work should spotlight human-automation system interaction to scope nearer-term evolutions of the UTM system
Most Recent Papers and Reports


