Panel Session #1
Human/Unmanned Systems Collaboration

- Large investment in UxVs

- State of the practice for most unmanned vehicles
  - Tele-operation, fly to waypoints; Currently many operators required
  - “Fully” autonomous only in simple environments with labor intensive pre-planned mission for air and undersea platforms
  - Increased manning instead of reduced manning
- Goal: Warfighter as supervisor, collaborator, peer
  - Hybrid teams of warfighters and autonomous systems that can be tasked and return filtered and appropriate information to multiple echelons



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"We can't have networks or platforms be at the center of the universe. I want networks and platforms that put Sailors at the center of the universe." Admiral Michael G. Mullen CNO, 2006

- Human-Centered Computing
- Scope and vision:
  - Hybrid force of heterogeneous unmanned systems with warfighters and manned systems
  - Management of systems/teams at a high-level
  - Systems that work as extension of warfighter; reduced cognitive load
  - Systems offering mixed-initiative decision making and interaction

Issues that affect interaction

- Proximal versus remote operations
- Appropriate modes of interaction
  - Using interaction methods that reduce cognitive load on warfighter; appropriate interaction and rate of interaction for system/mission (e.g. autonomous submarines have no interaction for long periods versus watchstations with constant, overloaded interactions)
- Role and makeup of user and team
  - Warfighters using assets versus requesting data; bystanders (i.e. non-combatants); types and distribution of unmanned systems; network availability and bandwidth (UAVs versus AUVs); manned team sharing assets
- Autonomy capabilities available on the unmanned system
  - How much assistance does system offer; neglect tolerance
- Solutions are highly multi-disciplinary!

Tough Problems

The following areas represent those which are not on track, do not have sufficient funds but with reasonable investments would have a significant impact:

- More natural modes of interaction that enable the warfighter to focus on the task, not the system; accommodating the warfighter
  - gestures, speech, multi-touch, gaze following, augmented reality, social behavior, dialog management, cognitive models, support for interruption resumptions, etc
- Cognitively compatible behavior during interaction to minimize human cognitive load
  - Cognitive skills, common ground, suitable ontology, social behavior
- Ability to understand intent and actions of human team members, adversaries and bystanders
  - Activity recognition, computational cognitive models; perception
- Trading off level's of autonomy dynamically
  - Mixed-initiative interaction, cognitive skills, core intelligent autonomy

Correlated Issues
(Also Tough)

- Acceptance and trust
  - Ability to explain actions; guarantee appropriate behavior
  - Activity recognition, computational cognitive models, “safe” adaptation etc.
- Appropriate metrics
  - E.g., how many assets can one warfighter realistically control given cognitive limitations and equipment limitations?
- Fusion of information and knowledge
  - Common ground, knowledge and data must be brought together and turned into usable information that is actionable

Future Capabilities

- Management of systems/teams at a high-level
  - Ability to *shape planning and behavior* of group of unmanned vehicles
  - Warfighter does not “control” individual platforms and instead *makes requests for information or action*
  - Can treat heterogeneous group of vehicles (air, ground, surface; different types of sensors) as a unit with range of capabilities. Tasks vehicles or groups based on information or result needed within op constraints
  - Tasking is in terms that are natural/appropriate and correspond to commanding other or human assets
  - N warfighters and M platforms -- multiple warfighters at multiple echelons can make requests of teams

Future Capabilities

- Advanced interfaces
  - More natural modes of interaction that enable the warfighter to focus on the task, not the system
  - Warfighters can use multiple modes of interaction including natural language, gestures (maps, etc), virtual or immersive environments
  - Cognitively compatible behavior during interaction to minimize human cognitive load. System responds in natural way
  - Ability to understand intent and actions of human team members, adversaries and bystanders
  - Alerting and recovery from interruption will allow faster and more accurate situation awareness
  - Error detection and correction

Future Capabilities

- Mixed-initiative
  - System allows trading off levels of autonomy dynamically and as appropriate; System can make decisions and be autonomous when required
  - Allows warfighter to attend to other tasks yet be alerted when attention is needed. System understands warfighters current level of cognitive load; can quickly bring warfighter to required level of situation awareness
  - System can explain its decisions and information on which its decisions are based. Increases warfighter trust of system
  - System can offer advice to warfighter

LCS MCM Mission Package Current State

Detect

Engage

Vehicle Operator | Payload Operator | Vehicle Operator | Payload Operator | Vehicle Operator | Vehicle Operator | Vehicle Operator | Payload Operator





LCS MCM Mission Package Ideal State

Detect

Detect Mission Operator(s)

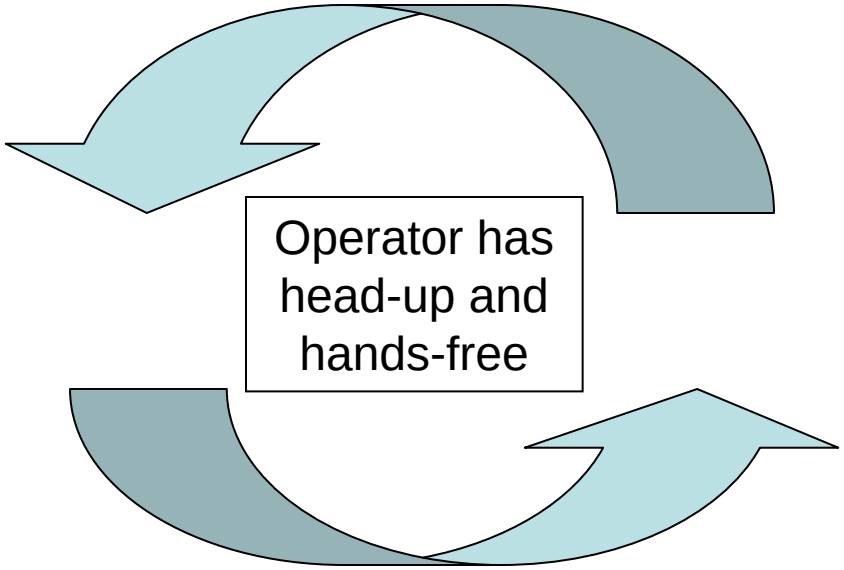



Engage

Engage Mission Operator(s)

More Natural Interaction

QuickTime™ and a
decompressor
are needed to see this picture.

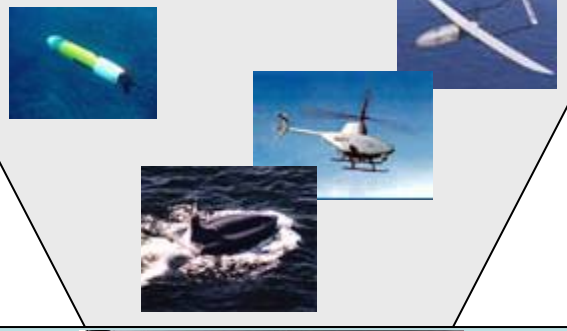


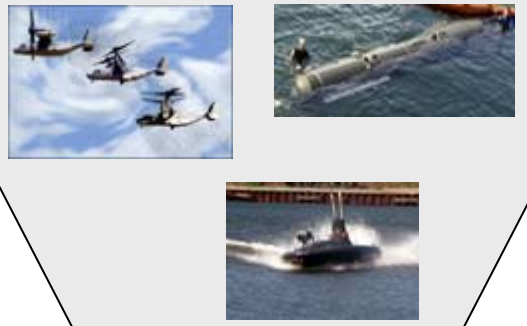
- Rich, multi-modal, and intuitive HRI
  - Automatic person detection, tracking, and following
  - Speech, tactile, vibration, etc.
  - Gesture recognition for physical command and control
- User requests services & provides tactical considerations
- Services from individual or teams of unmanned systems

Enables robots to be effective team members with **no controller hardware or displays needed** so **operator is heads-up and hands-free**

Collaborative Watchstations

Ship #1 ← **Interface Between Ships** → **Ship #2**





Vehicles with Varying Levels of Autonomy

- **Different interaction modes**
- **Share resources**
- **Collaborate**

- **Collaboration tools improve information sharing and team situation awareness**
- **Collaborative, intelligent decision aids**
- **Knowledge elicitation technologies to allow operators to rapidly input/tag data to support other users needs**

Unmanned Systems Common Control

Common UxV Human Interface

- Translate operators intent into specific mission objectives and constraints
- Multi-Objective Optimization, De-confliction
- Pre-mission Planning, Mission Monitoring, Re-planning, Post-Mission Analysis
- Support rapid response to contingencies/emergencies
- Airspace/Waterspace/Battle Space Management

Hybrid Force