



# Development of Prototype Intelligent Adaptive Interfaces for Multiple UAV Control

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Defence Research and  
Development Canada

Recherche et développement  
pour la défense Canada

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Canada



# Future Joint Operations





# Three Phases (2003 - 2006)

## 13IL - ADVANCED UAV/UCAV OPERATOR INTERFACE

		03-04				04-05				05-06										
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# Intelligent/Adaptive Interfaces (IAIs)

Goal	Situation
<ul style="list-style-type: none"><li>• <b>Improve</b>: efficiency, effectiveness, and naturalness of human-machine interaction</li><li>• <b>Maximize</b> overall performance</li></ul>	<ul style="list-style-type: none"><li>• <b>Multi-task capabilities</b></li><li>• <b>Dynamic monitoring of task processes</b></li><li>• <b>Integrated system design</b></li><li>• <b>Improved distributed team collaboration task capabilities</b></li></ul>

**Method: Multi-Agent Technology**



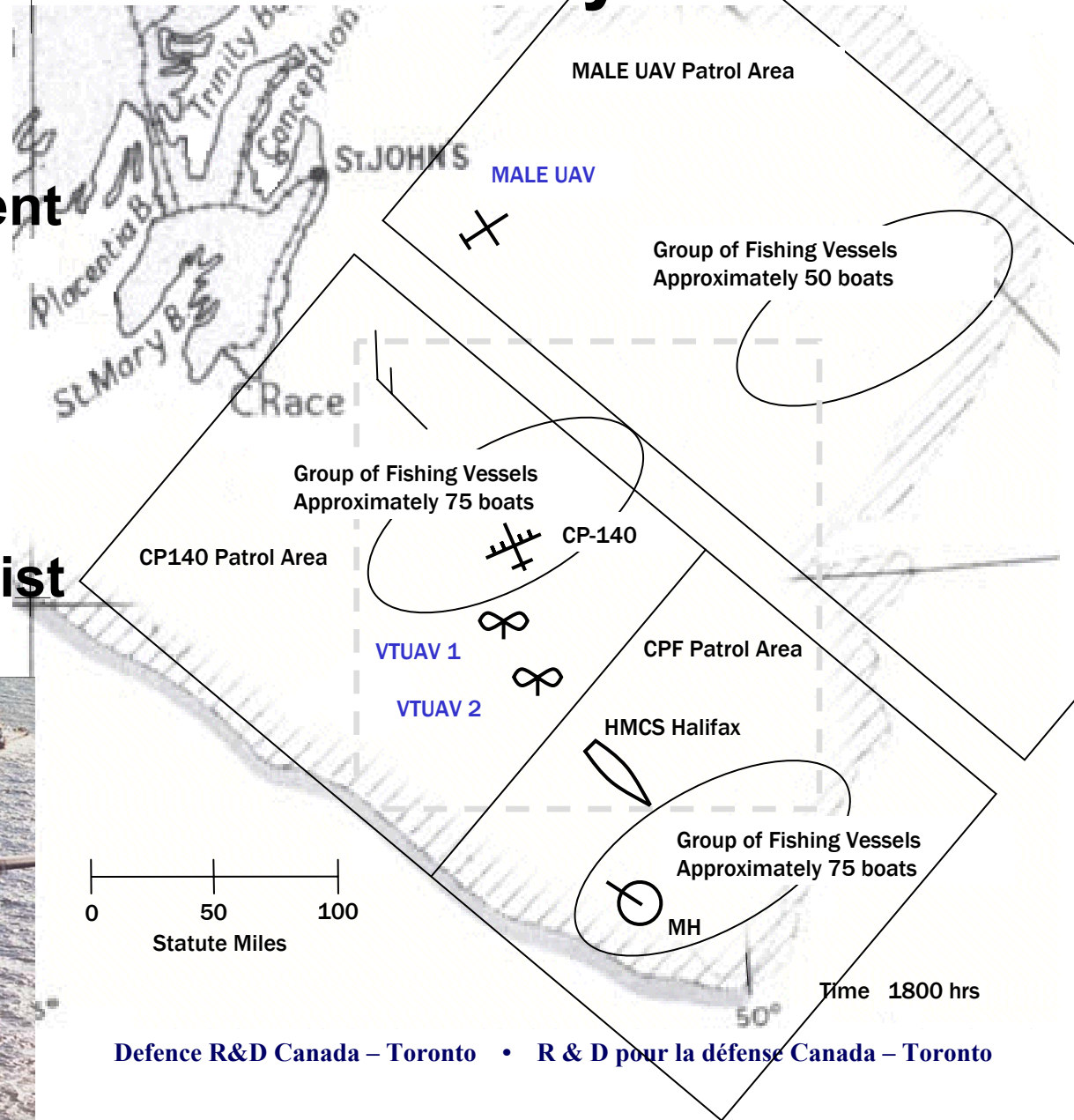
# Phase I Work (2003 - 2004)

- **Conceptual Design Framework for Optimising Operator-Agent Interaction**
- **Methodological Design Framework for Implementation of System Components**
- **Baseline Operational Scenario and Analysis of Anti-terrorism Mission**
- **Composite Scenario, Hierarchical Goal Analysis (HGA), & Performance Modeling**



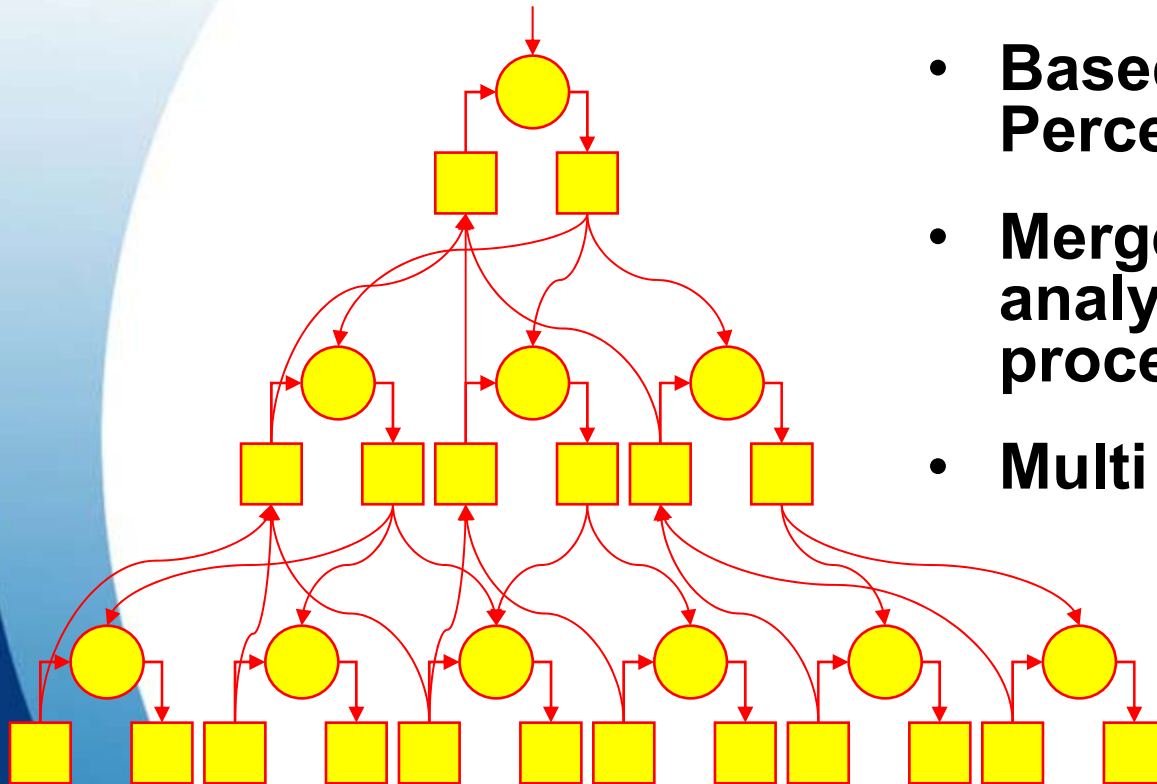
# Mission Scenario Analysis

- Commonwealth Heads of Government Meeting Security Arrangements
- Multi-UAVs (Mini, MALE, VTUAVs) searching for terrorist vessel





# Hierarchical Goal Analysis (HGA)



- **Based on William T Powers' Perceptual Control Theory**
- **Merge Function and Task analysis into a single process**
- **Multi agent architecture**



# Integrated Performance Modelling Environment (IPME)



- **IPME is a tool for front-end Human Factors analysis**
  - **Simulated timeline of human and machine activities**
  - **Predict operator workload, performance and error production**
- **Discrete event simulation**
- **Produced by MA&D**



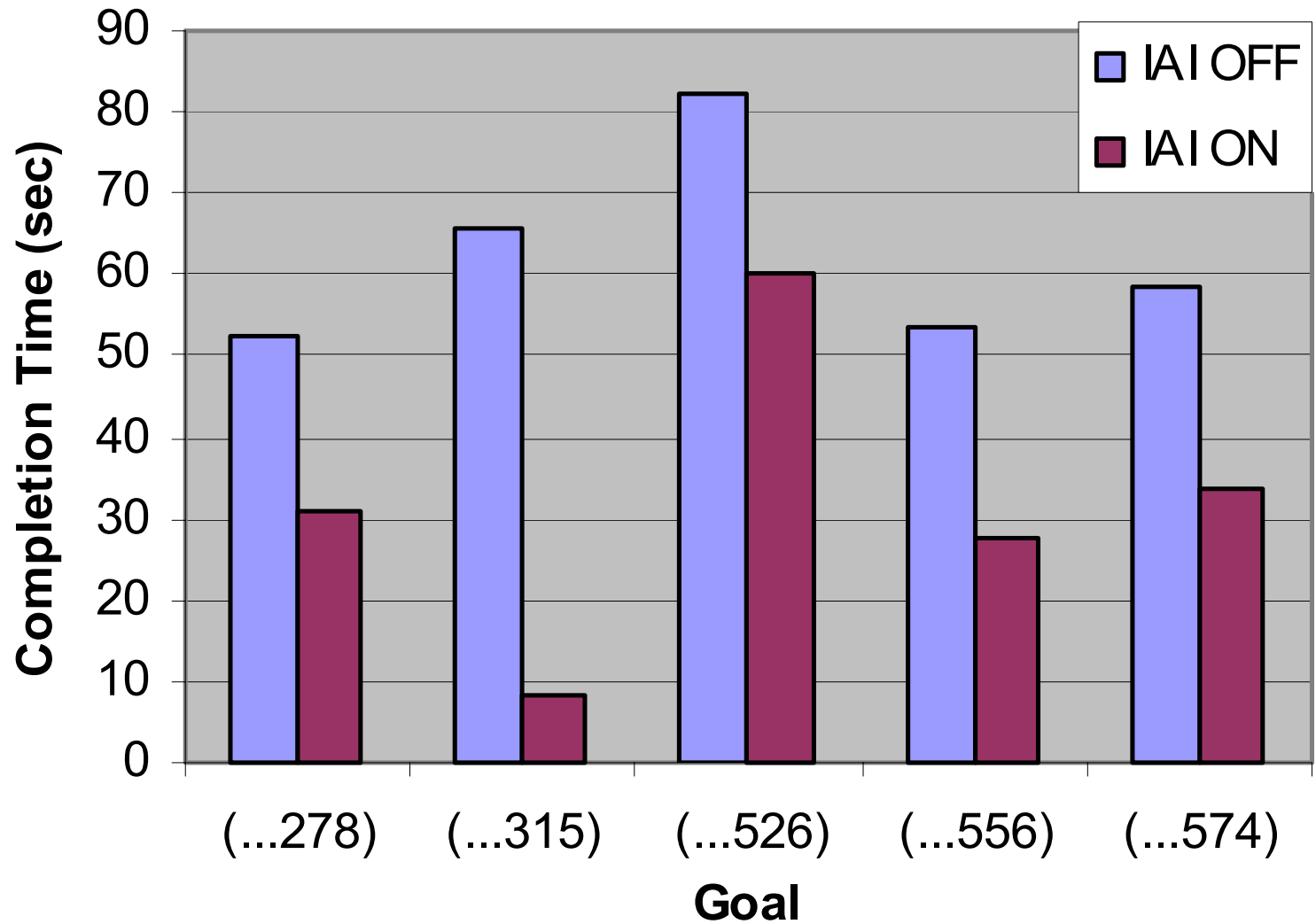
# Measures of Performance and Effectiveness

- **Percentage of time a crewmember is working with conflicting tasks**
- **Number of ongoing goals**
- **Instantaneous time pressure (workload)**
- **Completion time for critical tasks sequences**



# Goal Completion Time

## Example of Goal Completion Time (Part 3)





# Conclusions of Phase I Work

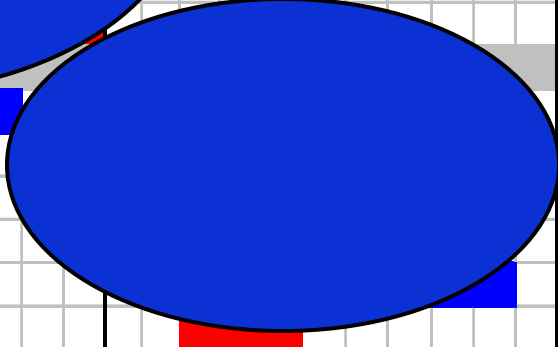
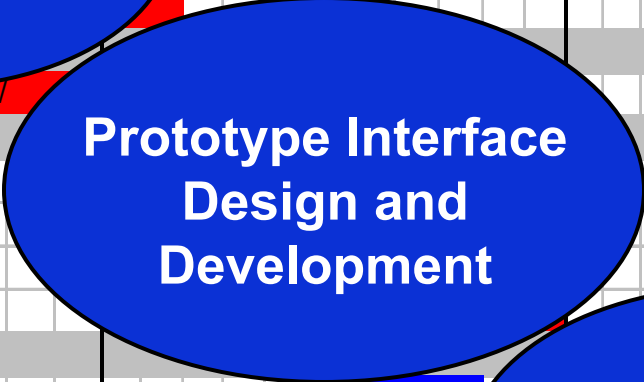
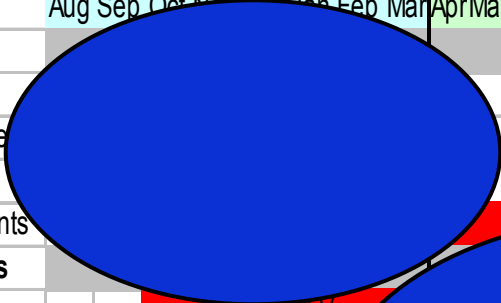
- 1. Improved performance was evident from IPME simulation results (with IAI ON)**
- 2. Use of intelligent assistance (e.g., navigation and communication agents) should be considered as IAI functions in cognitively complex environments such as UAV control system**



# Phase II (2004 - 2005)

## 13IL - ADVANCED UAV/UCAV OPERATOR INTERFACE

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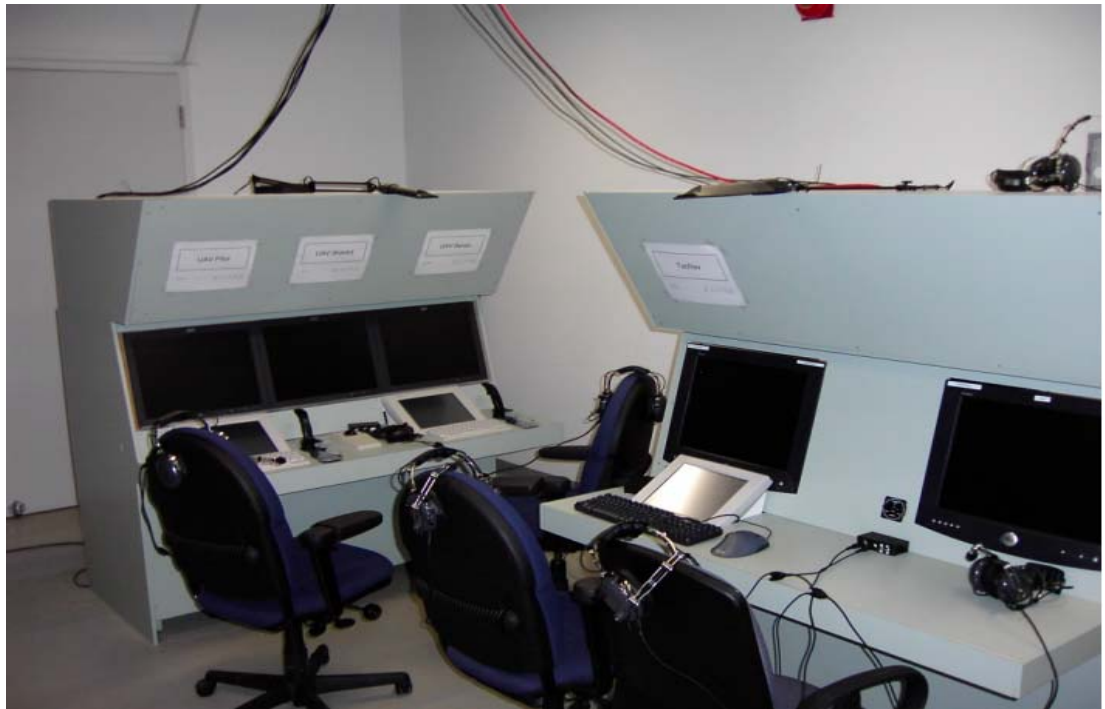
# Phase II Work

- **Development of design concepts for both conventional and IAI-based interfaces**
- **Verification on design concepts with Subjective Matter Experts (SMEs)**
- **Implementation of prototype interfaces for UAV pilot (UP), payload controller/ UAV sensor operator (UO), and tactical navigator (TACNAV)**
- **Evaluation of interfaces with SMEs**



## Phase II

- Created an operational scenario and experimental environment that crews found both complex and realistic.
- Produced an experimental environment suitable for an assessment of IAI





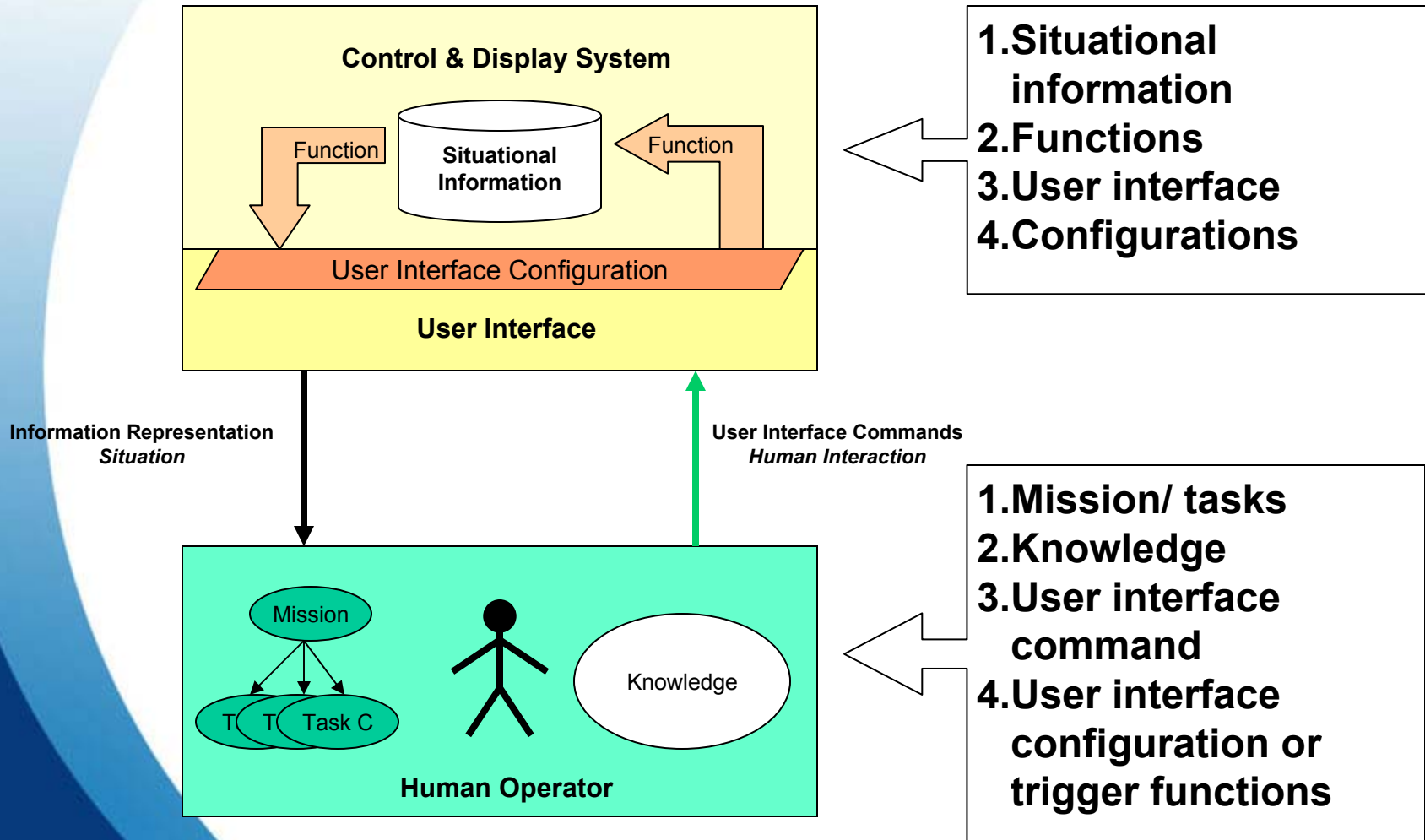
# Intelligent Adaptive Interface

- Comprehensive Investigation of IAI “State of the Art”
- Detailed IAI Interface Concept
- Produced Actual IAI Software (Agent JACK)
- IAI Software Development “Lessons Learned”
- IAI WoZ



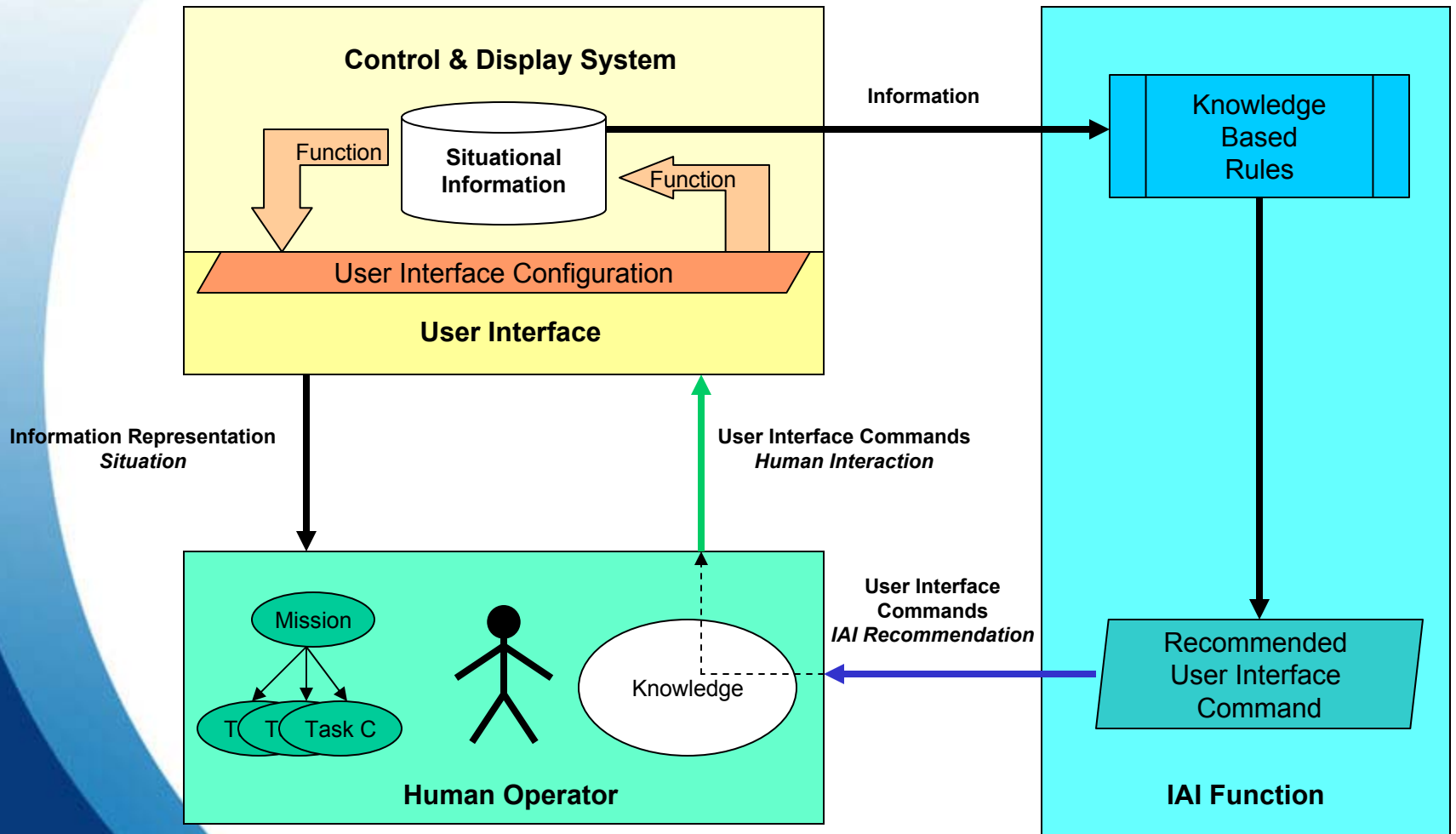


# Human-Computer Interaction Model



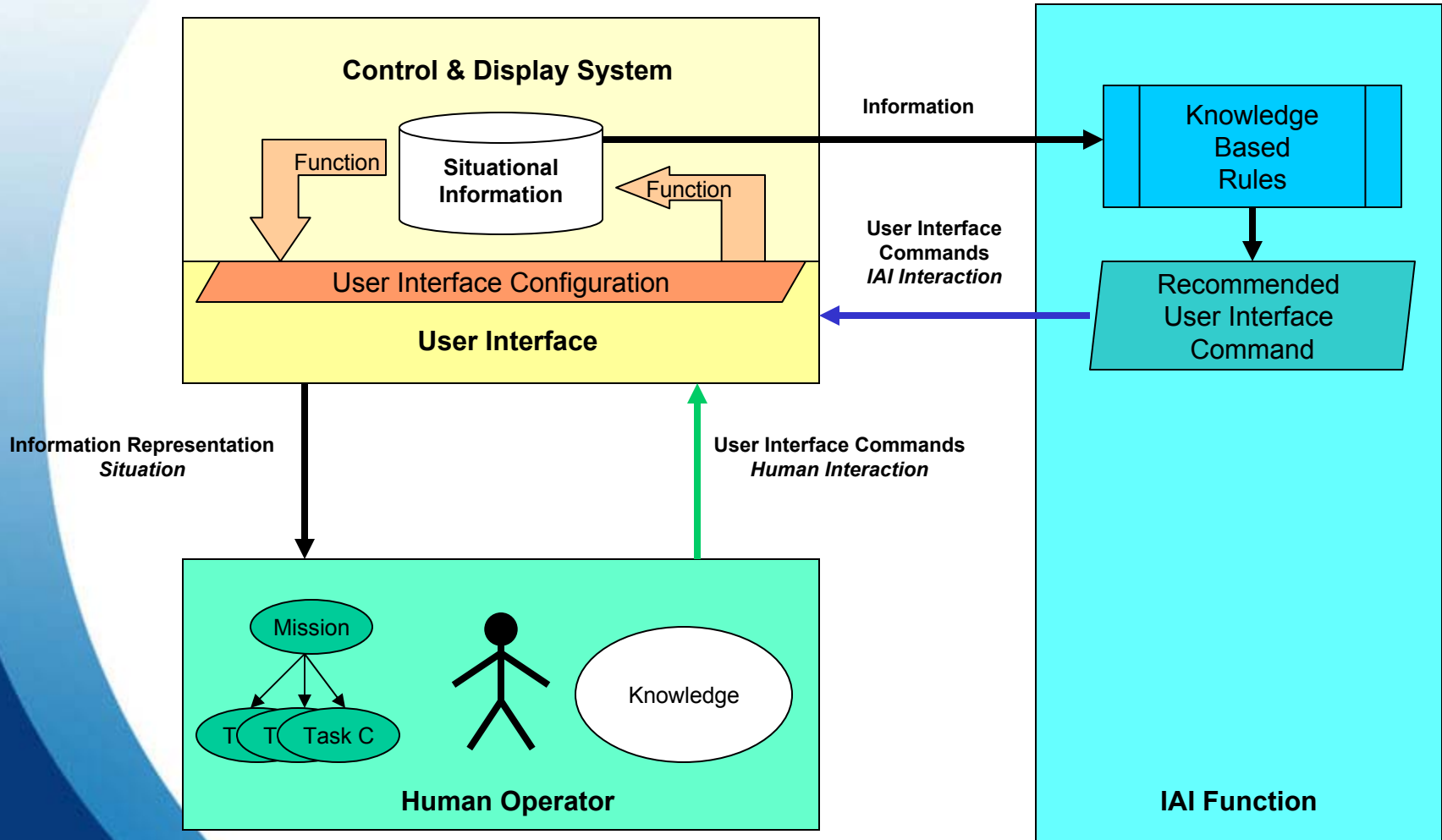


# IAI Function (supporting)



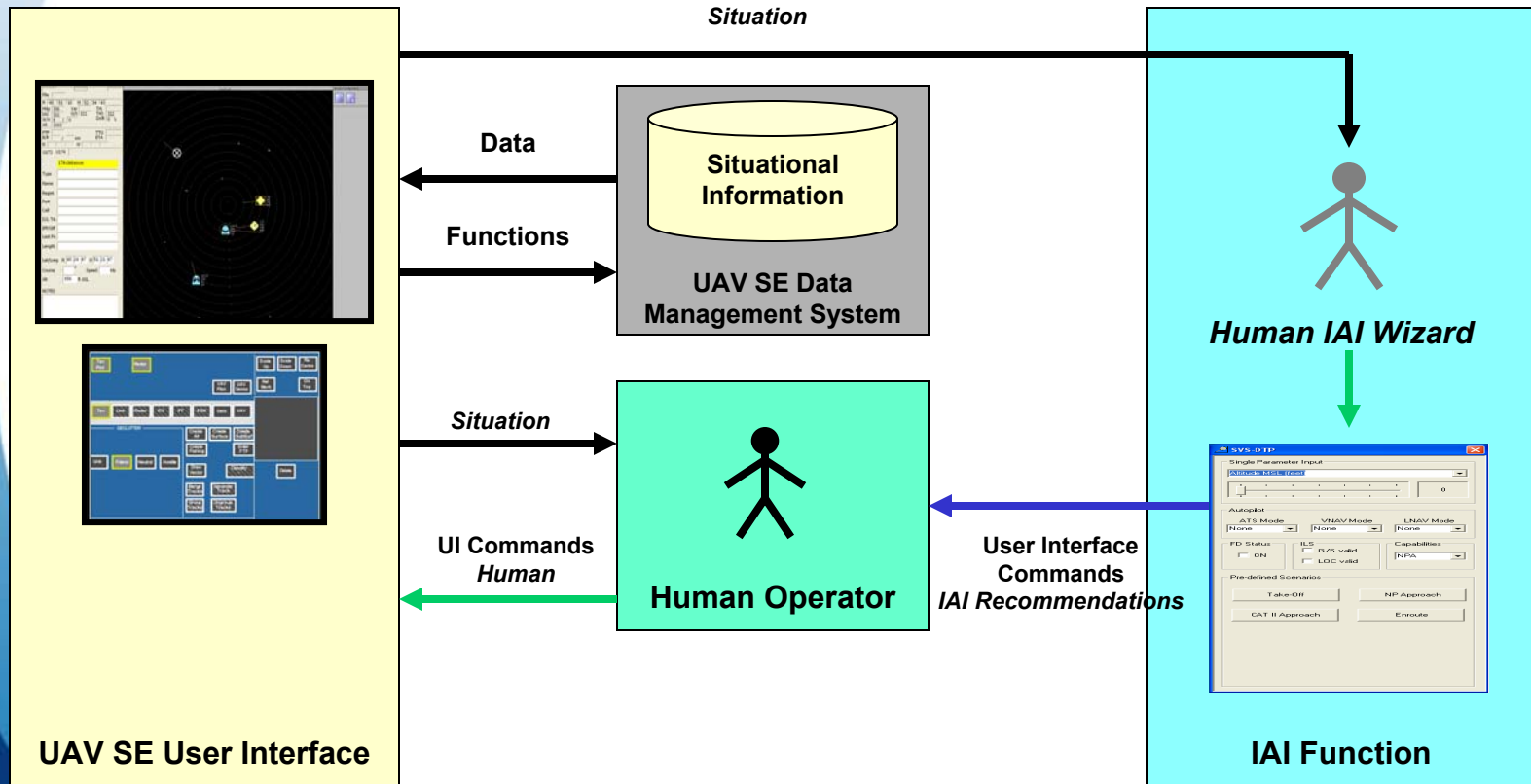


# IAI Function (autonomous)



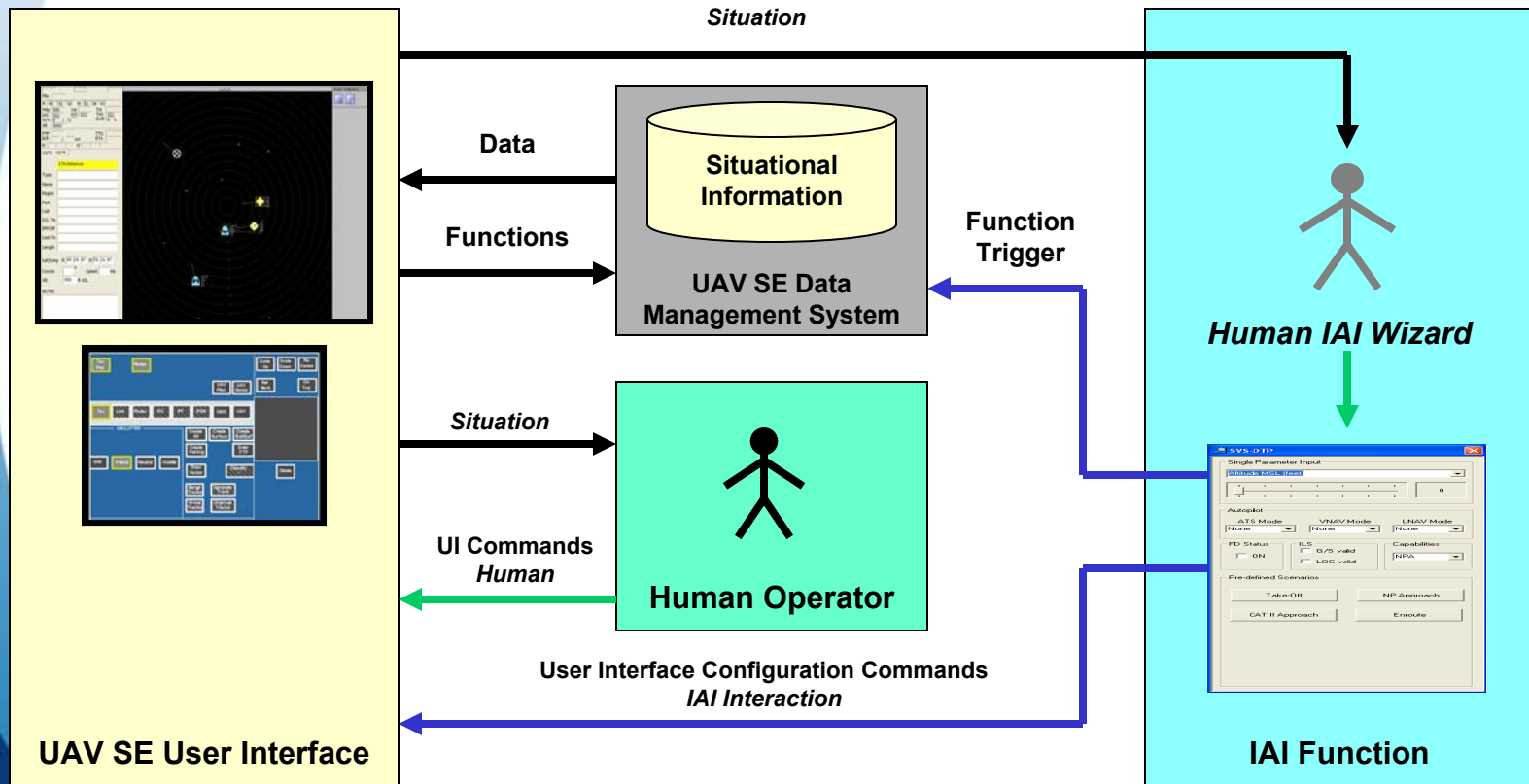


# IAI Implementation Concept (Supporting IAI Wizard)





# IAI Implementation Concept (Autonomous IAI Wizard)





# IAI Trial Implementation

IAI functions implemented:

- Inter-crew communications
- Route planning
- Screen Management
- Data Link monitoring
- UAV Sensor Selection

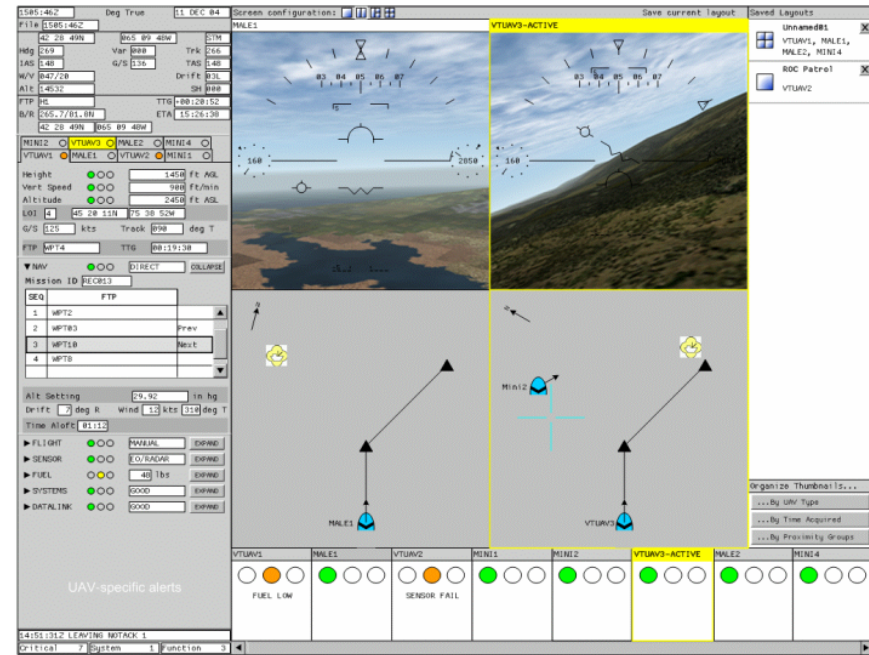
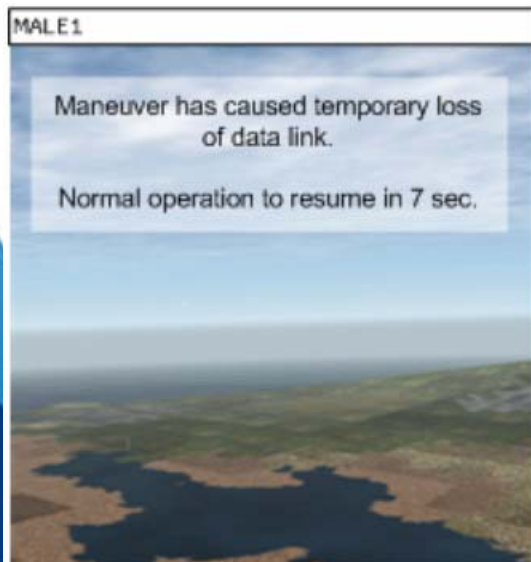


Figure 4-10 Primary Display for the UAV Pilot



# Test Environment

- Free-play OI including GUI and PEP for 3 Operators
- Data, Video and Audio Experiment Data Collection
- Multiple UAV Version of STRIVE
- 4586 Interface Software
- Physical Mock-up
- User Intercom
- 3D World





# Phase II Achievements

- Developed a full-dynamic simulation of three CP140 (P-3) workstations for multiple UAV control:
  - Comprehensive operational interface with 3D visuals for sensor image and pilot camera
  - Experimental functions allow intervention of all system functionality ("IAI Wizard of Oz")
  - Wide range of operational functions for UAV control, sensor operation and tactical management
  - Integrated with modern scenario and UAV simulation
  - Fully compliant with STANAG 4586



# Prototype Readiness Review (March, 2005)

A Prototype Readiness Review (Pilot Test) was conducted so that an assessment could be made of the appropriateness of the synthetic environment to conduct IAI assessment trials.





# Participants

Four SMEs from the MP&EU at CFB Greenwood visited to conduct the readiness review of the UAV control workstation prototypes and the associated experimental set-up.









# Conclusions

Designed an experiment that should have good power to uncover interface-related (e.g., IAI) performance effects

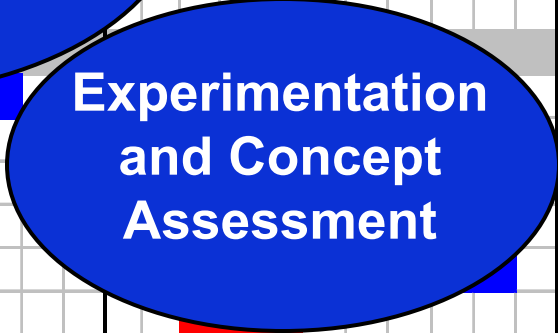
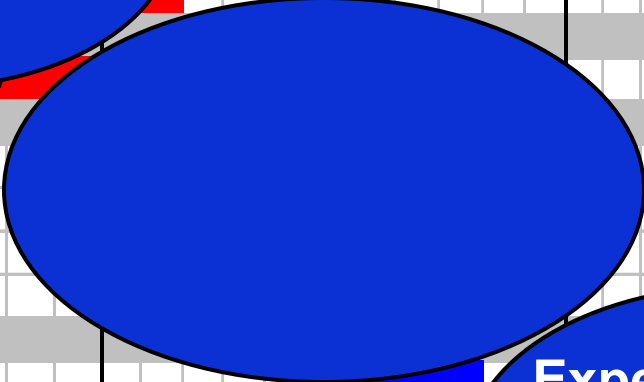
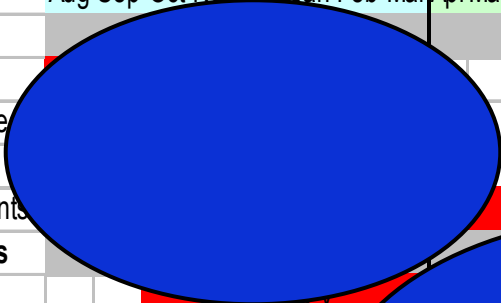




# Phase III (2005 - 2006)

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# Phase III (2005 - 2006) Experimentation

**Level of Automation  
(Interface Domain)**

IAI  
ON

IAI  
OFF

UO

UP

TACNAV

**Level of Temporal  
Workload  
(User Domain)**

Low

Med

High

**Level of Position  
Complexity  
(Task Domain)**



# Questions

