



Test Pilot's Role in Flight Test of Unmanned Air Vehicles

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Abstract

With Increasing Emphasis on the Development of Unmanned Air Vehicles (UAV), the Test Pilot May Be Assigned to Perform Various Duties on the UAV Test Team. The Purpose of This Briefing Is to Highlight Some of the Tasks That May Be Assigned to a Test Pilot on a UAV Test Team. Information on **Accomplishing These Tasks from Previous UAV Programs Are Presented.** The Information Is Derived Primarily from the Author's Experience Performing Duties as Chase Pilot, Surrogate Aircraft Test Pilot, and Air Vehicle Operator on Various UAV Flight Test **Programs.**



AVO role for UAV Analogous to Test Pilot Role

- AVO Role Defined in Early Design Decisions
- Command and Control Location
- AVO Display Requirements
- Surrogate Aircraft Flight Testing
- Chase Aircraft
- Contingency Planning
- Summary / Lessons Learned



AVO Role Defined in Early UAV Design Decisions

- Fully Autonomous UAV Range Safety Role
- Autonomous Takeoff / Landing UAV
 - AVO Cannot Manually Takeoff / Land the UAV
 - AVO Involved in Decisions Related to Taxi and Takeoff Abort, Contingency Profiles, Waveoff, Destruct
 - Limited Capability to Control Flight Path Manual Override Airspeed / Altitude / Bank Angle
- Manual Control of Takeoff / Flight Path / Landing
 - AVO Fully Responsible for Flight Path Control Through Remote Control Inputs



Command and Control Locations

- AVO in Cockpit of Chase Aircraft
 - -Communication Issues
 - -Removed from Engineering Decisions
- AVO in Remote Ground Based Location
 Same Issues as Inflight Location
- AVO Co-Located with Engineering Decisions
 - -Visual Response Supplements Net Communication
 - -Advantageous to Co-Locate AVO with RSO



Control Room Configuration

- AVO Visual with Test Director / Test Conductor / Engineers to Supplement Net Communication
- AVO Share Displayed Information with RSO
- Radio Communication with Ground Crew / Chase Aircraft / Tower / Range Control
- External Camera View of UAV Highly Desired
- Forward Looking Camera from UAV Critical for Landing Decisions

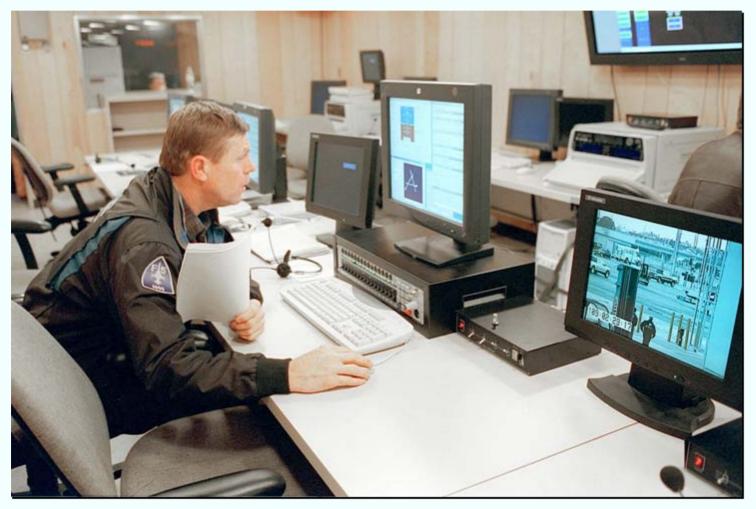


X-47A Control Room





X-47A AVO Station





AVO Command Display Requirements

- AVO Command and Control Panel
 - AVO Selects and Executes Commands to Be Uplinked to UAV Using Hardwired Panel or Computer Display (More Flexible / Transportable)
 - Need Feedback That Uplinked Command Was Sent (Use of Color Change on Display Is Effective)
 - "Echo" Command Is Useful
- Use of "Mouse" to Select Commands on Display
- Limited Keyboard Entry (i.e., Altimeter Setting, ZFW, Go to WP, Mission Plan Number, etc.)



Sample Command Display

💑 Command and Control Panel		
CCP DISPLAY OFF ENABLE CYCLE ECHO CANCEL EXECUTE		
Flight Termination Display		
DISARM		
Flight and Contingency Modes Display		
AUTO WAVEOFF DISABLE ENABLE GO TO WP		
L ORBIT R ORBIT DEORBIT WAVEOFF EMER RTB HOOK_EXTEND		
Flight and Navigation Override Display		
MANUAL OVERRIDE		
AIRSPEED ACCEL+5 ALTITUDE UP 500 BANK 15 30 45 60 DECEL-5 TURN LEFT WG LEVEL RIGHT		
Flight Test Inputs Display		
DOUBLET P Y/R POPU SWEEP PITCH ROLL YAW ABORT INPUT		
SIDESLIP LEFT RIGHT THROTTLE BODE POP UP BANK TO BANK		
Systems Reset Display		
EEC RESET VMS RESET ALTIMETER SET AIR DATA NORM INS		
BRAKES P A E SRGPS ON OFF GAIN NORM FIXED		
Start and Takeoff Display		
T/O POWER HOLD TAKEOFF T/O ABORT MMGC ON FUEL EMER OFF		
ENGINE OFF AUTO START INS ALIGN TAXI STOP TAXI IBIT STOP IBIT		
ZFW FUEL ALT START POSITION		
Socket Connection Connect C Disconnect		
Warnings, Cautions, and Advisories		
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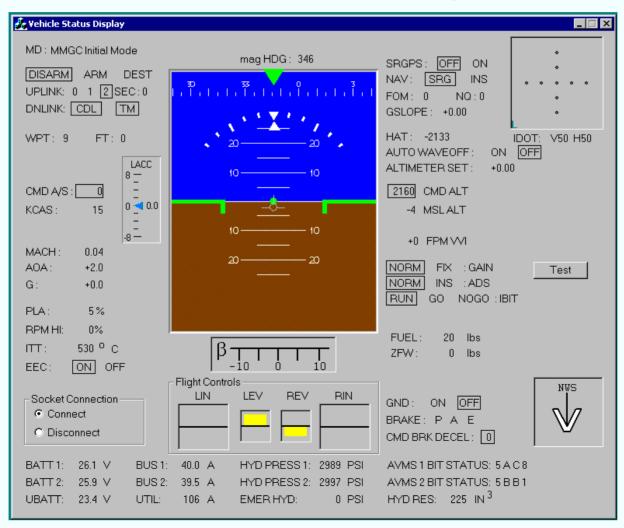


AVO Systems Monitor Display Requirements

- Vehicle Status Display
 - Monitor Current UAV Attitude, Flight Conditions, Basic System Status
 - Monitor Planned UAV Flight Conditions
 - Monitor Uplink and Downlink Status
 - -Feedback That "Commands" Were Received
 - Distance to Go to Waypoints Important
 - Telemetry Drop-Outs Are Really Irritating
 - -Consider Backup Method to TM Downlink (i.e., Command Data Link – Limited Bandwidth)



Sample Vehicle Status Display





Mission Situation Display (Range Map)

- Presents "Gods Eye" View of UAV Position in Relation to Planned Mission Track / Waypoints
 - Shows Waypoints / Routes Both Normal and Contingency Mission Plans
 - -Need "Declutter" of Unused Route Segments
 - -Need "Quick" Transition to Desired Segments
 - -Center on UAV With Ability to Vary Map Size
 - Display of UAV "Track History" Is Very Useful



Sample Mission Situation Display

MSD		- 🗆 🗵
Current Map Center Latitude: 35.6835 Longitude: -117.6800		
25.000 nmi		
Waypoint Display Start: 1 Set	- 4 22 + 23+ 2(826	
End: 31 All	·∲╪╦ड∲╋ã╠╪ ╤ड <mark>∲</mark> -26	
Aircraft centered mode Off		
On Socket Connection On Connect Disconnect		4
Exit	· · · · · · · · · · · · · · · · · · ·	



Surrogate Aircraft Flight Testing

- Manned Aircraft With "Some" UAV Systems Installed
 - -Check RF Links (Command and Control / TM)
 - -Check RF Links Used by UAV (GPS / Diff GPS)
 - -Verify Navigation Software
 - -AVO Range Familiarization Is by Product of Testing
- Aircraft Selection
 - -Verifying UAV Track Guidance Is Primary Task
 - Replicate UAV Altitude and Airspeed Is Optional
 - Keep It Simple (Display Range Map / Route / UAV Position on Laptop in Aircraft Reduces Aircraft Mods)



Surrogate Testing

- Testing with Beech Barron Provides the Following:
 - Data Link Range Limitations
 - Data Link Null Locations
 - -Profile Link Reception
 - -Quantitative NAV Performance
 - Integrated NAV / Mission
 Plan / Guidance /
 Control Verification







Chase Aircraft

- Both Photo and Safety Chase Requirements
- Practice Airborne Pickup With Control Room
- Chase of Surrogate Aircraft Good Practice
- Consider High / Low Chase for "Agile" UAV
- Thorough Brief With Chase Pilot / AVO Required
- Chase-Control Room Comm Is Very Important

 Photo Chase KIO Maneuver Must Be Preplanned
 "T" Word (Terminate) Is Not to Be Used



Contingency Planning

- Develop Useable "What If" Procedures
- What Ifs Should Lead to Limited Preplanned Options:
 - Continue on Mission Plan (or Orbit / Alternate Route)
 - RTB (Following Planned Contingency Routing) Destruct (or Let It Crash)
- Ground Contingencies Are AVO Memory Items
- Defined No Fly Zone Remaining Range Is OK to Fly
- Practice in Sim with All Engineer Stations Simulated
 - Develop Teamwork Attitude and Build
 - Confidence"Practice Like You Are Going to Play on Flight Day"



First Flight/Lessons Learned

- Plan Short Mission With Limited Objectives
- Follow Go / NoGo Criteria, FOLD, Test Cards
- Have Plenty of Fuel Onboard for Delays
- The "Real World" Contingency That Happens Will Not Be Anything You Planned
- Control Room Engineers Are Your Best WCA
- Remote "Flying" UAVs Requires Same Concentration and Test Discipline as Piloting Aircraft (but It Will Never Replace the "Real Thing"!)



Video of first flight of Pegasus

