Training the UAV Tester

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Note: The opinions expressed in this presentation do not reflect an official position of the U.S. Navy.

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The Problem

- Unmanned Air Vehicles (UAVs) a major part of NATO air arms
  - More so in the future
- UAVs require special test approaches and methods
- Existing training limited
  - One-two week short courses
  - A few lectures in Test Pilot School (TPS) long courses

Estimated Demand

U.S. Programs

Program	Service	Notes	Testers Required Per Year
MQ-4 Triton	Navy		2
MQ-8 Firescout	Navy	Rotary-wing-based training desired	1
MQ-25 Stingray	Navy	Carrier suitability exposure desired	2
Small UAS	Navy/Marine Corps		1
MQ-1 Gray Eagle	Army	Reciprocating engine test method training desired	1
RQ-4 Global Hawk	Air Force		2
MQ-9 Reaper	Air Force		2
RQ-170	Air Force	Or other classified programs	2
All	Flight test engineers		2 or more

- U.S. Demand is ~15/year
- Total NATO demand signal estimated at 20-24/year

Potential Solutions

- Short Courses (1-2 weeks)
  - Pro
    - Available today
    - Limited cost
  - Con
    - Limited depth of instruction
    - Very limited hands-on experience
- 10-11 Month TPS Long Course
  - Pro
    - In-depth instruction
  - Con
    - Perception of “second-class” TPS
      - Can they support manned aircraft programs?
    - 2-3 years to set up and produce graduates
      - Minimum

Potential Solutions

- Conversion Course
  - 6-12 week course
    - Full immersion
  - Students are
    - TPS graduates
    - Flight test engineers with 5+ years experience
      - Not new hires
  - Pro
    - Faster to set up
    - Tailorable as requirements change and lessons learned
    - Graduates retain manned flight test credentials
  - Con
    - Total training time longer than dedicated UAV TPS long course

Recommended Course of Action

- Conversion Course
  - Offer as adjunct to existing Test Pilot Schools
- May transition to TPS UAV long course at some point in the future
  - mid-2030s?

Resources

- Need something to fly
  - Representative of high end UAV capabilities

Parameter	Value	Notes
Service Ceiling	>20,000 ft	>50,000 ft desired for maximum deconfliction with traffic, and to simplify operations in national airspace
Airspeed	>200 KTAS	Higher speed desired for faster transit to/from test area
Endurance	10 hours	Enough time to allow for complex exercises to be performed by all students.
Links	2 beyond-line-of-sight links	Dual redundancy required for safety of operations
Autonomy	Strongly desired	Late-model UAVs are autonomous, testers can expect to be working with those, not joystick-controlled systems.
Auto-land capability	Strongly desired	Experience has shown auto-land to significantly reduce mishap rates.
Remote (beyond line of sight) launch and recovery	Strongly desired	Enables operation of the aircraft from an outlying field.
Sensors	EO/IR, radar with maritime search, ISAR, SAR modes	Not a primary capability, but very useful for teaching sensor testing.

Proposed Curriculum

Subject	Lecture	Flight or Ground Exercise
Historical Perspective	Brief overview of the development of unmanned aircraft and the technology.	Tours of UAV programs as available at training site.
Safety	Discuss safety policies and procedures specific to UAV testing	None
Test Program Management	Discuss management policies and issues observed in previous UAV test programs	None, possibly discussions with ITT leaders for major UAV programs.
Test Team Operations	Discuss operational issues encountered on UAV programs, including multi-shift operations, selection and training of Test Event Directors, and coordination of multiple ground stations and telemetry monitoring stations.	Ground event: Execute a simulated mission with multiple ground stations and telemetry monitoring stations. May be conducted as a flight event for student familiarization with UAV operations.
Surrogate Platforms	Discuss use of surrogate platforms to test basic technologies and solutions aimed at a specific platform or capability. Cover methods, safety precautions, and limitations.	Ground event: Tour of surrogate platforms/systems as available at training site.
Taxi Testing	Discuss test methods, data collection and analysis	Ground event: Plan and conduct taxi test exercise. If possible, with buildup to a takeoff abort.

Proposed Curriculum

Subject	Lecture	Flight or Ground Exercise
Stability & Control	Discuss the differences in approach between manned and unmanned aircraft. The basic principles of S&C remain the same, but the applications change dramatically when you start making the aircraft autonomous or nearly so. Classical S&C starts to warp when you deal with augmented flight control systems, and changes even more when dealing with UAV technology.	Flight 1: Exercise basic maneuvers. Show how classical open-loop testing is impossible without specialized test software. If it can be done safely, demonstrate contingency logic (RQ-4As and Bs can do a lost-link contingency without actually losing link - it's a quirk of the system).
Guidance Logic	Discuss the various approaches to autonomous and semi-autonomous guidance. May need to do a review of navigation systems. Be certain to discuss contingency logic. Discuss the trouble spots – that the guidance logic dominates what you can do with the airplane (meaning you need special software for some tests, trickery to perform other tests, and had better know exactly what that airplane is supposed to be doing ALL the time – including the guts of the contingency logic).	Flight 2: Have students plan and execute tests on FQ characteristics. Start with classical methods, then adapt to UAV systems. Include use of engineering test commands if possible. Also have students plan and execute mission-relatable tasks.
Mission Planning	Discuss mission plans, how they are used. Discuss timelines involved for mission planning, differences observed between vendors and services on the role of the mission plan in conducting a mission. Also discuss airfield survey requirements	Ground event: Have students plan a mission under supervision. If that mission plan can be used in a simulator, have the students fly their mission in the simulator.

Proposed Curriculum

Subject	Lecture	Flight or Ground Exercise
Communications Links	Discuss types of links (LOS vs SATCOM, also networks). Discuss link failure logic in both the aircraft and ground station – both what the system does to regain link, and what it does when the link can't be restored in a timely manner.	Flight event: Have students use communications links. Note differences in speed and capability. Probably concurrent with other flight events.
Performance	Discuss performance testing. Cover impact of high-precision GPS data on performance testing, and challenges of performance testing when the aircraft guidance system will not support conventional test techniques. Discuss CI/Mach cruise performance test methods. Note that supplemental lectures on performance theory for reciprocating engines may be appropriate, given the use of such for UAVs.	Flight event: Have students plan and conduct performance tests on a UAV. Essentially hand them the USNTPS fixed-wing or rotary-wing Perf Progress Check and have them try to do it with a UAV. Possible flight or ground event: Have students conduct performance testing using CI/Mach methods.
Sensors	Discuss sensor control issues (how do you perform a closed-loop tracking task with a 1-sec control system lag?). Discuss the current trend to provide radar tracks, but not raw data – and the implications for flight testing. There may be a need for a quick generic sensor testing refresher.	Flight event 1: Have students plan and conduct EO/IR testing with UAV systems. Qualitative and quantitative evaluation. Flight event 2: Have students plan and conduct radar testing with UAV systems. Qualitative and quantitative evaluation. Possible Flight Event 3: Have students plan and conduct mission-based eval of ALL available sensors.

Proposed Curriculum

Subject	Lecture	Flight or Ground Exercise
Human Factors	Discuss the presentation of flight, aircraft health & status, and sensor data to the aircrew. Pay close attention to operator task saturation issues, particularly as they apply over a 6-10 hour shift. Discuss how the aircrew get commands up to the airplane – including risk factors when you are using the same controller for multiple purposes (IIRC, that cost the USAF a Predator). This is a big area.	Ground event: Examine all available ground stations. Work through representative mission tasks, including emergency procedures. Flight event: Same, except in flight.
Reliability and Maintainability	Discuss the greater role that the maintenance crew have – often, they start the aircraft and hand it over to the crew with many of the systems already active and checked out. This may imply having maintenance personnel with test training. Also discuss the startup procedures for the ground station. Discuss specialized hardware.	Ground event: Observe start-up and shut-down procedures of all available UAV systems. If possible, perform these tasks under supervision.
Networks & Dissemination	Discuss the connectivity portion of unmanned aviation. IA issues. Analysis and dissemination of intelligence product. Retasking, and the effects of retasking on aircrew workload.	Ground event: If possible, work a shift in a UAV exploitation and dissemination node under instruction/supervision.

Proposed Curriculum

Subject	Lecture	Flight or Ground Exercise
First Flight	Discuss planning and execution considerations for first flight.	Ground event: Plan a first flight. If time permits, make this a flight event as well with simulated problems (both technical and administrative)
Combat Test	Discuss likelihood of operational deployment of test assets. Discuss planning considerations WRT number of test aircraft, ground stations, specialized maintenance equipment, and manning.	Ground event: Plan a test program with and without combat test requirements incorporated.
Manned/ Unmanned Hybrid Systems	Discuss applications of UAV-like capabilities to manned aircraft systems. Discuss test approaches and criteria.	Ground event: Plan a test of a UAV-like capability such as autonomous collision avoidance.
Training Systems	Discuss UAV aircrew and maintainer training systems and test approaches. Discuss pressures on assets that can be caused by the ability to switch some resources, such as ground stations, from training to mission support functions	Ground event: If possible, tour training facilities.
Highly Autonomous Systems	Discuss highly autonomous (decisions made by aircraft, not by human) systems. Discuss test approaches for such systems, including SIL test resources	Ground event: Plan a test program for highly autonomous systems. If possible, execute tests with either a simulated or actual highly autonomous system. Note that this may be do-able with automobile navigation systems at a reasonable cost.

Proposed Curriculum

Subject	Lecture	Flight or Ground Exercise
Swarming	Discuss swarming systems. Characteristics, advantages, and drawbacks. Safety of test considerations.	Ground event: Plan a test with either a simulated or actual swarming system. Flight event: If possible, execute a test event with swarming systems. Full or partial simulation would be acceptable.
Loyal Wingman Technology	Discuss Loyal Wingman technologies, including use as auxiliary weapons, sensor, and EW platforms. Discuss test approaches.	Ground event: Plan a test of Loyal Wingman maneuvering. Flight event: If possible, execute a test event to evaluate a Loyal Wingman system. Simulated would be acceptable.
Qual-Eval	Familiarization with a broad spectrum of large UAVs.	Plan and execute a nominal 4-8 hour test flight on an aircraft the students have not flown. Repeat as availability permits.

Path Forward

- Need to organize resources
  - Money
  - Offices
  - Airspace
  - Instructors
- Probably best to associate with an existing Test Pilot School
  - One, or a consortium
  - But they can’t take it out of hide

Path Forward

- Airframes
  - Surplus MQ-9 or RQ-4 Block 20?
  - MQ-8B?
- Timeline
  - 1-2 years to organize
  - Need a working group ASAP

Conclusion

- UAVs will be a major part of the future
- Testing UAVs requires specialized knowledge/skills
- Need a training program that has adequate depth
- 6-12 week Conversion Course seems like best option at this point

- Time to get started on a solution

Questions?