The United States Air Force Test Pilot School

“Knowledge is Power”

John L. Minor
Technical Director, USAF Test Pilot School
USAF TPS Vision & Mission

- **VISION:** World’s premiere educational & training center of excellence for theoretical and applied flight test engineering

- **MISSION:** Produce highly-adaptive critical-thinking flight test professionals to lead & conduct full-spectrum test & evaluation of aerospace weapon systems

Testers exert huge (often unseen) influence over weapon systems
1944 Established at Wright Field

1951 Moved to Edwards AFB

1961 Aerospace Research Pilot (ARP) Course Added
Renamed USAF ARPS

1972 ARP Course Terminated
Systems Phase Added
Renamed USAF TPS

1973 FTE Program Initiated

1977 FTN Program Initiated

1990 TMP Phase Added

2000 Short Courses Added
USAF TPS Graduate Trivia

2,468 Total Graduates (1944-2004)

- Thomas D. White USAF Space Trophy: 11
- David C. Schilling Award: 16
- Mackay Trophy: 7
- National Aviation Hall of Fame: 11
- J. H. Doolittle Award: 11
- Robert J. Collier Trophy: 17
- Iven C. Kincheloe Award: 37
- Harmon International Trophy: 16
- Octave Chanute Award: 12
- Lancaster Walk of Honor: 21
- Aviator’s Valor Award (Brig Gen Yeager & Senator Knight): 2
# Eligibility Requirements

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<tr>
<th>Course</th>
<th>Time in Service</th>
<th>Education</th>
<th>Experience</th>
<th>Physical Qualification</th>
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<tr>
<td>PILOT</td>
<td>≤ 10 yr</td>
<td>BS in Engineering, Math, or Physics</td>
<td>750 hr or IP (MWS)</td>
<td>Annual Flying Class II</td>
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<td>12 mo AC in MWS</td>
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<td>NAVIGATOR</td>
<td>≤ 10 yr</td>
<td>BS in Engineering, Math, or Physics</td>
<td>500 hr or IN (MWS)</td>
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<td>ENGINEER</td>
<td>≤ 8 yr</td>
<td>BS in Engineering, Math, or Physics</td>
<td>≥ 2 yr experience in 13XX, 14NX, 21AX, 21CX, 21LX, 21MX, 33SX, 61SX, 62EX 63AX</td>
<td>Annual Flying Class III</td>
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<td>Technical Masters highly desired</td>
<td>(civ: ≥ 2 yr in T&amp;E)</td>
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# Current Student Stats

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<tr>
<th>Class</th>
<th>Pilots</th>
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<th>Engineers</th>
<th>Aircraft</th>
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<td>F-15, F-16, C-130, C-17, B-52, KC-135</td>
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<td>UNITED KINGDOM</td>
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**GRAND TOTAL 304**
• 48 Weeks of Intensive Training
• 4 Major Phases of Training
  – Performance
  – Flying Qualities
  – Systems
  – Test Management
• 387 hrs academic instruction
• 135 hrs flight training + 79 hrs ground school (pilots)
• 20 scored academic tests
• 21 graded written reports (15 written + 6 oral)
• Capstone Test Management Project
• Comprehensive Written & Oral Exams
PERF = Performance
FQ = Flying Qualities
TMP = Test Management Project
QEP = Qualitative Evaluation Program
Learning Paradigm
An Applications-Oriented Pedagogy

Train the way we Fight...  ...Teach the way we Test
• The Most Difficult Step
  – Requires Time for Reflection
    • RECOMMEND
    • CONCLUDE
    • ANALYZE
  – Stimulates $\alpha$-level Neural Activity
  – The “E” in T&E

➢ 95% of a BS program remains at knowledge level
➢ What we mean when we say “Critical Thinking”
Performance Phase

**Purpose**
- Basic flight test methodology
- Learn test program conduct
- Motion of the aircraft C.G.
  "How far, how fast, how high…"

**Courses**
- Introduction to Aerodynamics
- Compressible Aerodynamics
- Data Standardization
- Air Data System Calibration
- Energy Concepts
- Takeoff and Landing
- Cruise
- Modeling and Simulation
- Propulsion

**Resources**
- 65 hr Performance Theory
- 16 hr Flight Test Techniques
- 25 flt hr-pilots (20 flt hr-FTE/Ns)
  - Data Group acft
  - Gliders
  - C-12
  - HU-16
- 8 flt hr (pilots only)
  - T-38 & F-16
- 8 flt hr crew solo (data groups)
  - C-12, F-16 or T-38
Flying Qualities Phase

**Purpose**
- Evaluate aircraft flying qualities
- Aero & flight control system models
- Motion of aircraft about its C.G.

**Courses**
- Equations of Motion
- Trim & Stability
- Handling Qualities Evaluation
- Flight Control Systems
- Aero-Servo-Elasticity
- Stall and High AoA
- Flight Test Simulators
- First Flight Testing
- Envelope Expansion Testing
- Failure State Testing
- Structures
- Stores Certification

**Resources**
- 126 hr Flying Qualities Theory
- 29 hr Flight Test Techniques
- 3 hr Handling Qualities Sims
- 49 flt hr-pilots (33 flt hr FTE/Ns)
  - Glider FQ & spins
  - T-38 FQ, HQ & stalls
  - Var-Stab Learjet / VISTA
  - F-15 Asym Stores
  - F-16 High AoA & LCO
**Systems Phase**

**Purpose**
- Evaluate aircraft systems
  - Performance, Suitability, Human Factors, Pilot Vehicle Interface
- Exposure to wide variety of systems

**Courses**
- Human Factors
- EO & IR systems
- Radar systems
- Electronic Warfare systems
- Integrated Navigation systems
- Weapons Delivery Testing
- Smart Weapons
- Avionics Systems Integration
- Integrated Systems Evaluations
- Data Link systems
- UAVs

**Resources**
- 84 hr Systems Theory
- 14 hr Flight Test Techniques
- 18 hr Labs (22 hr FTE/Ns)
- 5x F-16 IFAST Labs (6x FTE/Ns)
- 15 flt hr-pilots (11 flt hr FTE/Ns)
- BAF tour
- NTTR field trip
- 2-dy UAL field trip (B777 & A320)
**Purpose**

- Spans entire curriculum
- Test management
  - Systems acquisition process
- Capstone Test Management Project
  - Real world / real customer
- Experience broadening in wide variety of aircraft (Qual Eval Pgm)
- Reporting in multiple formats

**Courses**

- Test Management Course
- Test Safety (UTSO) Training
- Qual Eval Demo FTT
- Deficiency Reporting
- All-Weather Testing
- Test Conduct
- DOE / Probability & Statistics
- Technical Writing
- Instrumentation

**Resources**

- 53 hr Academics
- 1 hr Flight Test Techniques
- 10-12 flights in non-curricular aircraft
- Test Management Project
  - AFFTC/Customer-sponsored
  - Major oral & written report ("greenback-equivalent")
Staff/Student Test Management Project (TMP)

Research Opportunities

• **What are TMPs?**
  – Limited Scope/Duration Flight Test Projects
  – Conducted by Students and/or World-Class TPS Staff
  – Approx 10-15 fighter hours or 20-25 heavy hours
  – Conduct ~ 8 Projects/Year (4 in Spring, 4 in Fall)

• **Customer Provides:**
  – Research concept or “widget” to be flight tested
  – $$$ for any specialized support or major acft mods

• **TPS Provides:**
  – Test Aircraft - Usually flown on AFFTC Assets
  – Dedicated Test Team of Pilots/Engineers (4-6 individuals)
  – $$$ for Flight Hours, “minor” acft mods, T&E
  – Flight Test Data, Data Reduction, Data Analysis
  – DTIC-Ready Technical Report
Hands-Off Aerial Refueling

Student-designed computer program and control system could help increase deployment range and endurance of UAVs

DAVID FULGHUM/WASHINGTON

Two U.S. Air Force test pilot school students have designed an autonomous aerial refueling scheme for an unmanned tanker and an unmanned combat aircraft, and have completed a test flight program.

Capt. Chris Spinelli designed a program for the two aircraft’s carrier phase differential GPS systems. Capt. Steve Ross designed a control system for the Learjet (surrogate unmanned aircraft).

Bank-angle and roll-rate measurements and the relative positions of the C-12 (surrogate tanker, top) were recorded and linked to the receiver aircraft. These inputs manipulated the control surfaces and throttles, automatically allowing the aircraft to hold a series of positions and transitions while flying a standard racetrack course, even when the tanker was in a 30-deg. bank. By the final flights, pilots kept their hands off the controls for nearly 2 hrs. In straight-and-level flight, the controller held the receiver within 1.3 ft. of the desired refueling position.

The students believe this to be the first demonstration of autonomous aerial refueling maneuvers over a standard racetrack course. The capability is expected to increase unmanned aircraft deployments and decrease dependence on in-theater bases while extending range and on-station time.
Variable Stability In-Flight Simulator Test Aircraft
What is VISTA?

- Variable-Stability In-Flight Simulator Test Aircraft
- Highly modified Peace Marble II Block 30 F-16D
- Capable of hi-fi sim of aircraft “model” in real flight environment
- Rapidly reconfigurable H/W & S/W
- Provides a platform for FQ, Systems, TMP, Research:
  - technology and S/W demos (e.g. Auto ACAS)
  - flight control conceptual research (e.g. MATV)
  - high credibility handling qualities evaluations (e.g. HAVE ROVER)
  - realistic environment cockpit display flight tests (e.g. JSF, ASAR, HUD)

A unique national asset…sets USAF TPS apart!
Student VISTA
Research Projects/TMPs

98B HAVE TRACK   HUD Target as Substitute Aircraft Target for HQ Evals
00A HAVE OLOP    PIO in the Presence of Rate Limiting
00B HAVE ATTITUDE Off-Axis Attitude Cueing for Helmet Mounted Sights
01A HAVE ROVER   PIO Detection and Suppression
01B HAVE GRAPE   Collect GPS TSPI data for follow-on TCAS testing
02A HAVE PREVENT Comparison of PIO Prevention Algorithms
02B HAVE SYCLOPS Flight Reference Displays
03A MAX GAP      PIO Prediction Algorithms
03B SELF SERVE   Autonomous Rendezvous for AAR
04A SOLO FORM    Automatic Formation Flight
04A DOLLAR DRAFT Refine Positioning for Formation Cruise Drag Reduction
2001  **Helmet Mounted Display Demo**  
   *Air National Guard Weapons Conference*

2003  **Helmet Mounted Assembly**  
   *British Aerospace Engineering*

2003  **Automatic Air Collision Avoidance System (Auto ACAS)**  
   *AFRL/VA (SETP - Tony Levier Safety Award)*

2004  **Arc Segment Attitude Reference (ASAR), Head-Up Display (HUD)**  
   *AFRL/HEVC*
Qualitative Evaluation Program
(1representative aircraft)

- Builds a broad foundation of experience
- Exposure to unique civil/military aircraft
- Reinforce TPS curriculum learning objectives
  - Performance, flying qualities, systems and mission suitability
- Evaluates students’ abilities to plan, execute and report a unique and unfamiliar flight test experience
- Builds confidence to handle new flight test situations in a systemic/logical manner (build-up approach)
### Short Courses

- **Senior Executive Short Course** 3 days
- **EW Flight Test Engineering Short Course** 4 days
- **Aerospace Vehicle Test Course** 4 weeks
- **Test Management Short Courses** 4 days - 3 weeks
- **Propulsion Academic Course** 4 days
- **Equations of Motion Flight Test Course** 3 days
- **UAV Flight Test Course (newest course)** 3 weeks

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Huge TPS Growth Area
The First UAV Flight Test Class

- Fully Autonomous Mode
- Manual Back Up Mode
- Upload New Mission “On the Fly”
Build Up Approach

3 week course

Labs

Academics

Simulators

Flight Test Project

1 week

2 weeks
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<td>AM</td>
<td>Keynote / Intro History of UAVs</td>
<td>UAV Missions - Systems - Flight Envelopes EO/IR Sensors</td>
<td>SAR</td>
<td>Data Link C² (EMI/EMC)</td>
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Typical Training Mission

(Video)
Target Geolocation Accuracy
Sensor FOV to Map Overlay (P3I)
Students reduce, analyze, and evaluate data from actual flight test exercises. This is where students achieve the higher levels of learning by reinforcing academic principles and theory learned in the classroom.
On the Horizon…

• **ACCREDITATION**
  – *MS in Flight Test Engineering (ABET)*
    • Requires change to USC Title 10
    • USN TPS, EPNER, EMPIRE “on-board”
    • AFIT/USAFA Fully Support this Effort
    • Request currently with HQ USAF
    • Likely to be the Most Significant Driver of Long-term Institutional Change
Graduate Core Competencies

- **Diverse Aerospace Vehicle Exposure**
- **Flight Test Engineering**
- **Flight Test Techniques**
- **Flight Test Planning**
- **Safety Planning & Risk Management**
- **Flight Test Execution**
- **Data Management**
- **Flight Test Evaluation**
- **Flight Test Reporting**
- **Integrated Test Teaming**

= **Full-Spectrum Flight Test Professional**
Summary

• USAF TPS takes the world’s best operational Pilots, WSO/Navs and Engineers and produces the world’s best highly adaptive, critical thinking, leaders in flight test and evaluation

• Result: Best Weapon Systems for the Warfighters

• SAFETY in T&E is our #1 PRIORITY

• Very Challenging 48-week program

• Best year of their lives!