Air Force Test Pilot School Strategic Plan

THE FUTURE FORCE

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COL. JAMES VALPIANI COMMANDANT AIR FORCE TEST PILOT SCHOOL



On April 18, 1942, Lt. Col. Jimmy Doolittle led 80 Airmen in launching 16 B-25s off the deck of the U.S.S. Hornet in a clandestine military mission destined to change the course of World War II. Far from a reckless act of bravado, Doolittle's extraordinary act was the fruit of the extensive flight test experience and mastery of calculated risk honed during his studies at TPS's precursor, the Air

School of Application, and throughout his time as the Army Air Corps' chief test pilot. Today, over 80 years later, we again face the specter of great power competition with nations whose military capabilities rival our own. Our nation's need for Airmen and Guardians of extraordinary test skill and judgment in the mold of Doolittle could not be greater.

What challenges do TPS graduates following in the footsteps of Jimmy Doolittle face? First, as **testers** they must be prepared to plan, execute, analyze and report on elevated-risk tests of an extraordinary array of technology spanning over 70 years of air, space, and cyber development. Second, as **test leaders** in an era of accelerated, highly integrated development cycles, they must be able to build cohesive test teams out of diverse stakeholders to convert test insights into decision and action. Third, as **critical thinkers**, they must be able to continually adapt their test strategies to highly dynamic strategic and acquisitions contexts generated by great power competition. Fourth, as **innovators** at every stage and level of capability development, graduates must be familiar with cutting-edge technologies and ways to leverage them for the warfighter's benefit. In particular, the advent of the machine learning era, with its ubiquity of large datasets and rapid advancements in sensing, controls and decision-making aids, presents a generational opportunity and challenge for test innovation.

As the Air Force's sole academic institution dedicated to the test profession, TPS has a long and storied history of evolving to meet each era's defining challenges. Indeed, our 80-year history is one of constant change, from the earliest days of performance testing, to our decade as the nation's astronaut training program, to the addition of mission systems test and ever-expanding test tracks such as flight test engineer, remotely piloted aircraft tester and space tester. In light of our strategic context and the emergence of data-driven test, TPS must again evolve to prepare graduates for the challenges ahead – but how?

TPS must expand its mission set. We can only prepare graduates for a future dominated by data science by applying its principles to test firsthand. So, like all academic institutions that live on the cutting edge of technology, TPS must invest time and resources in **research**, particularly test-related applications of data science, to ensure our instructors and our curriculum directly address the **data-driven test** challenges that await our graduates. Relatedly, TPS must **broaden** its curriculum competencies to ensure graduates are prepared to build and lead increasingly integrated and dynamic test coalitions. Additionally, we must formally prepare and **develop** our instructors to maximize and retain their talents in an era of widespread opportunities for test leadership. To enable these initiatives, we must **restructure** our time for research, continuous curriculum modernization and a more holistic set of graduate competencies. Further, TPS must **renew** our test assets and infrastructure to provide relevant hands-on experience at the heart of our education. While TPS modernization encompasses several initiatives, it may be summarized as *resourcing and restructuring TPS to develop our staff and create leaders ready for data-driven test*.

This TPS strategic plan presents the lines of effort and key initiatives necessary to modernize the school for the evolving role of test leaders. It makes explicit the three interdependent elements of TPS's mission – **students, staff and research** – and commits time and resources to each. With respect to its educational mission, the strategic plan introduces the Test Leader Course, which aims to develop our graduates in four key pillars – **testers, leaders, thinkers, and innovators** – with a particular emphasis on data-driven test. The strategic actions outlined in this document will align TPS to strategic need and evolve the school's structure, curriculum and resource base accordingly.

It is an honor and a privilege to be part of the TPS team. Together, we will carry on our school's proud legacy of rising to the nation's call for test leadership, in an era of great power competition and the transformative power of modern data science.

JAMES M. VALPIANI, Colonel, U.S. Air Force Commandant, U.S. Air Force Test Pilot School

VISION

Testers, Leaders, Thinkers, Innovators... in the Mold of Jimmy Doolittle

To prepare graduates for rapid technological change and growing strategic challenges, TPS draws inspiration from the test leader par excellence, Lt. Gen. Jimmy Doolittle.

As the Army Air Corps flight test chief, Doolittle led a year-long test campaign alongside scientists, engineers, philanthropists and aviators to invent the artificial horizon and accomplish the world's first blind flight. Over 10 years later, he led a three-month high-risk test campaign with nearly one hundred aviators, bombardiers, navigators, engineers, acquirers and industry partners in heavily modifying the B-25 fuel system, weapon system and outer mold line; calibrating the engines for maximum range; and reducing takeoff rolls from 800 feet to under 300 feet at thousands of pounds over the published max gross weight of the aircraft to enable carrier takeoffs. The test teams Doolittle built enabled life-saving instrument flight and the historic Doolittle Raid, respectively.

In both instances, Doolittle demonstrated four key attributes. First, he modeled the tester's mindset via his disciplined, risk-aware exploration of the unknown. Second, he modeled integrated test leadership in forming diverse stakeholders into cohesive teams with a



disciplined test culture. Third, he modeled critical thinking in adapting test campaigns to the strategic and technological contexts. Fourth, he modeled test innovation in applying emerging technologies to capability development. These four attributes form the pillars of TPS's vision – testers, leaders, thinkers, innovators.



ETHOS

Credible, Adaptable, Warfighter-Focused

Test Pilot School staff and graduates are united by our commitment to the school's ethos. **Credibility** is the bedrock upon which our staff and graduates convert hard-won test insights into decision and action. **Adaptability** is necessary to accomplish our test mission in the face of rapidly advancing technologies and shifting strategic contexts. Being **Warfighter-focused** ensures we keep our end goal firmly in mind – accelerating capabilities to the warfighters who we serve.

MISSION

Create Test Leaders, Develop School Staff and Conduct Test Research to Accelerate Multidomain Capabilities to the Warfighter

The school has one mission – to accelerate multidomain capabilities to the warfighter. We advance our mission in three interconnected ways – by creating test leaders, developing our staff and conducting test research.



Figure 1. TPS Goals

STAFF GOAL

Unified Community of Deliberately Developed Staff Committed to Educational Excellence

The Test Pilot School is home to the world's foremost flight and space test experts alongside world-class support and administrative staff. To retain our talented teammates, ensure our staff continues to grow and prepare new instructors to meet our high standards of educational excellence, the school invests time and resources to deliberately develop our staff and community.

SCHOOL GOAL

Highly Adaptive Critical-Thinking Test Leaders

To meet evolving strategic challenges, our graduates must be highly-adaptive. Likewise, there are no standard solutions to the complex challenges our graduates will face; they must be critical-thinkers. Finally, our graduates lead the test community in their first test assignments and beyond.

The Test Pilot School screens for candidates with demonstrated operational and engineering excellence, leadership, critical thinking and an innovative spirit. To operational and engineering excellence, we add preparation for first flight operations and complex mission systems test. To leadership experience, we add preparation for test-unique challenges, above all forming cohesive teams from diverse stakeholders and developing test culture. To critical thinking skills, we add exposure to strategic, warfighting and acquisition contexts, so graduates are prepared to develop context-appropriate test strategies. Finally, we expose students to emerging technologies, notably data science themes such as machine learning and data analytics, to enable test innovation.

RESEARCH GOAL

Novel Tools, Techniques and Frameworks to Advance the Art and Science of Test, Develop Staff and Enhance the Curriculum

TPS is the innovation engine for the DAF test enterprise. TPS staff and students invest dedicated time and resources to identify novel test tools, test techniques and test frameworks to address pressing challenges faced by execution-focused test units. TPS uses these research challenges to grow our staff, prepare our graduates and enhance our curriculum.

OUTCOMES

STAFF GOAL

TPS Staff will:

UNIFIED COMMUNITY

Build and sustain a culture of

and future of the school

inclusive dialogue about the identity

Analyze, fairly distribute and report

DELIBERATE DEVELOPMENT

Develop deliberately via leadership,

Work at a sustainable pace to include

training, skills-based programs,

academic degrees, professional conferences, fellowships, research

adequate time and resources to

advance school, staff and research

EDUCATIONAL EXCELLENCE

Apply fundamentals of curriculum

design; fundamentals of classroom

and event instruction; and manage-

ment of curriculum administration

opportunities and exchange

assignments

goals

on the school workload annually

Actively recruit highly talented

military and civilian members

to join the TPS Staff

SCHOOL GOAL



TPS Graduates will:

TESTER

Synthesize test fundamentals, domain-specific knowledge, and test skill sets to decompose requirements of a warfighting system; develop test objectives; assess and mitigate risk; and develop an effective, efficient, secure and safe test plan

Execute effective, efficient, secure and safe test; collect required data; deliberately accept risk; and adapt to a dynamic test environment

Analyze and evaluate test data to formulate conclusions and recommendations based on mission and requirements

Synthesize information from multiple sources and apply knowledge of stakeholder roles, perspectives and priorities to communicate test requirements, plans, risks and results clearly and compellingly

TEST LEADER

Build and direct integrated, multidisciplinary test teams and broad stakeholder coalitions to accomplish test and warfighter objectives

Apply leadership/ instructorship frameworks and skills to build and sustain a professional test culture

CRITICAL THINKER

Assess, evaluate and adapt to the strategic, warfighting and technological contexts relevant to the test mission

TEST INNOVATOR

Research and enable new ideas, methods and tech to accelerate test and delivery of warfighting capabilities.

Apply data science principles, test foundations and domain knowledge in analyzing large test datasets and testing data-driven systems



TPS Research will:

NOVEL TOOLS, TECHNIQUES AND FRAMEWORKS

Build and sustain partnerships to appraise and address emerging test challenges

Research and develop novel test techniques, planning frameworks and tools for emerging test challenges

FOR THE COMMUNITY

Report on and promulgate novel test solutions to the test community

FOR STAFF

Develop and sustain research expertise via deliberate advanced academic degree topic selection, staff development and talent recruitment.

FOR THE CURRICULUM

Integrate novel test techniques, planning frameworks and tools into the curriculum to prepare students for emerging test challenges

Sustain a culture of continuing education; self- and peer evaluations in classrooms and events; and deliberate mentorship of junior instructors

Regularly integrate with test units to appraise the evolving test mission and make time each year to modernize the curriculum accordingly

STRATEGY MAP

TPS Modernization: *Resourcing and Restructuring TPS to Develop Our Staff and Create Leaders Ready for Data-Driven Test*

TPS's mission, goals, vision and outcomes are linked by four lines of effort (LOEs). Three key initiatives from within our LOEs provide focus and unity to TPS modernization.

Figure 2. TPS Strategy Map



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LINES OF EFFORT



Develop Our Staff

Our staff members are the wellspring of TPS's mission success. We will pursue initiatives that formally develop our staff so that they can more effectively invest in the next generation of test leaders.

🕬 Key Initiative 1

1.1 ESTABLISH A FORMAL TEST INSTRUCTOR COURSE (TIC): TPS will establish a formal training course to prepare military and civilian instructors for operational and classroom instruction consistent with a formal flying training unit and graduate-level accredited schoolhouse.

The TIC dedicates time each summer to rapidly and professionally preparing inbound instructors for master's-level classroom instruction and graduate-level ops instruction. This will significantly increase instructor availability and educational quality/standardization.

Figure 3. Test Instructor Course Curriculum Structure



1.2 ESTABLISH FACULTY DEVELOPMENT PLANS: TPS leadership will document a development plan for instructors to maximize their potential and post-TPS success.

1.3 ESTABLISH AN INSTRUCTOR MENTORSHIP PROGRAM: TPS will make time for formal mentorship of junior faculty, and establish regular phase briefs for ongoing faculty development.

1.4 ESTABLISH A FACULTY FELLOWSHIP PROGRAM: TPS will send faculty on test-related fellowships to ensure the relevance of the curriculum and to advance individual development goals.

1.5 ESTABLISH A STAFF-TO-GRADUATE PROGRAM: TPS will establish a program to recruit high-quality civilian staff members with a pipeline to graduate status.



Modernize Our Curriculum

We will systematically modernize our curriculum, consistent with educational best practices, to provide students foundational knowledge and hands-on experience with the most complex leadership and technical challenges that await them upon graduation. In particular, the school will prepare graduates for data-driven test.

• Key Initiative 2

2.1 INCORPORATE DATA-DRIVEN TEST: TPS will establish data science courses for data analytics and data-driven control and will incorporate data science into all curriculum courses (read more on page 12, *Spotlight on Data Science*).



2.2 INCREASE CURRICULUM ALIGNMENT, COHERENCE and STANDARDIZATION: TPS will establish a standardization program to: drive alignment between program outcomes and course objectives, restructure the curriculum for coherent build-up and ensure quality instruction.

2.3 INCORPORATE STUDENT-CENTRIC LEARNING: TPS will incorporate an explicit focus on student-centric learning in classroom structure and exercises to maximize education quality and instructor time.

2.4 INTEGRATE FLIGHT and SPACE CURRICULA: TPS will deliberately develop academic content, exercises and processes that merge the air and space domains wherever possible.

2.5 FORMALIZE CLASSIFIED MISSION SYSTEMS CURRICULUM: TPS will leverage its classified program portfolio and networks to formalize classified mission systems courses with homework, tests, etc.

2.6 INCORPORATE TEST LEADERSHIP and INNOVATION: TPS will establish courses, case studies, and guest speaker series to prepare students for the challenges of test leadership, especially in building diverse coalitions, establishing test culture and leading innovation.

2.7 INCORPORATE ADVANCED TEST and SAFETY RISK MANAGEMENT: TPS will establish courses exposing students to advanced risk management concepts for complex systems.



Advance Test Research

Academic institutions are uniquely suited to advance their community through cutting-edge research. In turn, research is the means by which academic institutes keep their content relevant and up to date. We will invest time and resources to advance key areas of research, with a particular emphasis on data-driven test.

3.1 ALIGN ADVANCED ACADEMIC DEGREE STUDENTS TO STRATEGIC PRIORITIES: TPS will intentionally select and mentor pipeline instructors to advance active areas of TPS research and curriculum.

3.2 FULLY RESOURCE THE TPS RESEARCH PROGRAM: TPS will secure resources to enable robust research, will seek out cutting-edge research projects and partnerships, and will assign all faculty to research projects to advance the curriculum.

LOE

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Renew Our Resources and Processes

As an academic institute on the frontier of advanced technology, it is vital that the TPS has access to a modern suite of test assets and infrastructure and a commensurate budget and security posture. We will modernize our operational assets, infrastructure, security posture, processes and tools to provide a relevant test education.

• Key Initiative 3

4.1 RESTRUCTURE FOR ALL TPS GOALS AND EDUCATIONAL PILLARS: TPS will restructure to allocate dedicated time for staff development and targeted test research efforts. Additionally, TPS will allocate time for all four tester, leader, thinker and innovator pillars.



Figure 5. Test Leader Course Curriculum Structure

(continued on the following page)

Key Initiative 3 (continued)

TPS modernization requires time and resource investments in two key respects. First, at the level of our mission and goals, we must invest in deliberately developing staff and conducting test research. Second, within our school goal, we must invest in the pillars of test leadership, critical thinking and test innovation. The Test Leader Course is structured to enable these investments. The TLC consists of two cohorts of 24 Flight Test Course and 12 Space Test Course students each, beginning in July and January. The TLC dedicates time each summer and winter to the Test Instructor Course, test research and course modernization, and instructor fellowships (a major recruiting/retention tool). During these same periods, the TLC dedicates time to the test leader, critical thinker, and test innovator pillars via custom courses.

4.2 PLAN AND PROGRAM FOR NEW FLEET, SIM, LAB AND SPACE ASSETS: TPS will advocate and plan for upgraded operational assets with an emphasis on a replacement trainer, fifth-plus generation aircraft, remotely piloted aircraft, heavy aircraft, advanced mission systems testbeds, sims, labs and space assets.

4.3 PLAN/PROGRAM FOR A NEW BUILDING: TPS will advocate and plan for a new building that will provide adequate space for the Flight Test Course, Space Test Course and Enlisted Test Course, as well as classified academics and operations.

4.4 PROFESSIONALIZE SECURITY POSTURE: TPS will establish robust security processes and secure a robust baseline set of security read-ins to ensure its curriculum and hands-on events, labs and case studies properly prepare graduates for the latest systems under test.

4.5 MODERNIZE ADMINISTRATIVE AND FINANCIAL PROCESSES: TPS will upgrade administrative and financial processes to maximize productivity and minimize bureaucratic friction.

4.6 MODERNIZE LEARNING AND CURRICULUM MANAGEMENT TOOLS: TPS will adopt the latest tools for learning and curriculum management.



SPOTLIGHT ON DATA SCIENCE

Until recently, science, engineering and test have progressed via increasingly sophisticated mathematical models linking system inputs to outputs – analytic methods. Advances in computer processing and ubiquitous labelled data have enabled a new approach to science, engineering and test, whereby complex statistical and optimization algorithms process large quantities of data to uncover low-order patterns that link system inputs to outputs – data analytics. These patterns, encoded in opaque mathematical constructs such as neural networks, can be employed to control dynamic systems – data-driven control.

The data-driven approach enables scientists and engineers to analyze and control systems that are too complex or that have too many dimensions for humans to solve with analytic methods alone. Industry's rapid adoption of data analytics and data-driven control brings new opportunities, uncertainties and risk to the test profession. With the imminent arrival of the Joint Simulation Environment (JSE) and Collaborative Combat Aircraft (CCA), TPS graduates have a pressing need for formal education in data-driven test, which TPS is not presently structured to provide.



Figure 6. Data-Driven Test Definitions

The TLC incorporates a data-science backbone which spans the entire curriculum year. This backbone is built on a three-phase model of science and engineering as applied to dynamic systems: analytic solutions, computer-aided analysis and data-driven methods (see Figure 6). This framework is introduced in the emerging tech custom course, where about 80 students and staff each year gain hands-on experience with data-driven analysis and control in academic and industrial applications far in advance of aerospace – i.e., robotics, self-driving vehicles, etc.

Building on this foundation, students take two core data science courses designed to give them hands-on experience with machine learning for flight and space sciences and mission systems applications (see Figure 4). In parallel, faculty use the summer period to conduct research into data-driven analytics and control, which they apply directly to the curriculum. So, for instance, pitot-statics fundamentals and associated flight test techniques will continue to be taught from an analytic perspective to provide domain-specific intuition, but in addition, computer-aided methods such as Extended Kalman Filters and data-driven methods such a neural networks will also be taught to expose students to multiple methods for calibrating air data systems.

Data-driven test education will culminate in capstone data science exercises include testing multiple reinforcementlearning-based AI agents in the X-62A and analyzing large data sets generated from large force test exercises in the Joint Simulation Environment. Using a combination of partnerships, and dedicating time for faculty research and course modernization, TPS will be postured to prepare graduates for the JSE and CCA challenge problems.

STRATEGIC ALIGNMENT

Our LOEs are strategically aligned to the objectives of the 412th Test Wing, Air Force Test Center, STARCOM, Air Force Material Command, and the Department of the Air Force.

Figure 7. Strategic Alignment - Lines of Effort





2023-2024 Accomplishments

LOE 1	 Inaugural Test Instructor Course Three inaugural TPS instructor fellowships to NASA JSC, and DARPA Developing Staff-to-Graduate program
LOE 2	 Test foundations and mission systems courses integrated between Flight and Space Test Courses Inaugural AI/ML Fundamentals for Test course Six test leadership case studies completed including B-21, NGAD, F-35, DARPA Combat Autonomy and Orbital Warfare; guest speakers included the Secretary of the Air Force, Anduril CEO, and EpiSci Chief Technology Officer
LOE 3	 World's first automated dogfighting between AI agents in the X-62 and a crewed F-16 Collier Trophy finalist, Aviation Week Annual Laureate winner, and Society of Flight Test Engineers Test Team of the Year Advanced multiple classified test efforts with direct strategic and operational impact
LOE 4	 AFTC-approved acquisition of three A-29s for spins, weapons, E0 and datalinks test Incorporated FoX open mission systems architecture into TPS C-12s Space operations floor on track for opening in 2024 First live satellite test ops Procured flatsat for component-level space test education Preliminary plans for new TPS building complete Professionalized financial tracking and prediction Stabilized ops and educational scheduling, prioritizing predictability for staff quality of life Transitioning to Canvas as learning management system Developed multi-domain classified projects portfolio for staff and students

SUMMARY

Great power competition impacts every aspect of our nation's military capability development. To meet this present moment, TPS graduates must be well-versed in test fundamentals, adept at analytic test methods, and knowledgeable about the opportunities and risks of data-driven test. Furthermore, TPS graduates must be able to build and lead diverse stakeholder coalitions in increasingly complex contexts and accelerating development cycles. In short, TPS graduates must be **testers**, integrated test **leaders**, **critical thinkers** and **innovators** – following the test leader par excellence, Jimmy Doolittle. This strategic plan – along with the boldness, calculated risk-taking and initiative that are hallmarks of our test enterprise – will ensure we carry on the school's proud tradition of creating the world's finest test leaders in support of our Air Force and our nation.







https://www.edwards.af.mil/units/usaftps/