Combat Relevant Task:

The Test & Evaluation of the Lightweight Fighter Prototypes

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Wade A. Scrogham

**Air Force Test Center History Office,
Edwards Air Force Base, California**

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INTRODUCTION

Everything was atypical: the team, the mission, the technologies that we had to deal with. It had never been seen before. Everything that we did was barrier breaking.

– John W. Hicks

The Lightweight Fighter Program of the early 1970s is considered one the most successful competitive prototyping efforts in the history of American military aviation. What began as a mere technology demonstration evolved into a direct competition between the General Dynamics YF-16 "Viper" and the Northrop YF-17 "Cobra." With success anything but certain, the men and women of the Lightweight Fighter Joint Test Force (JTF) overcame political, logistical, and technological challenges to complete flight test of both aircraft within the span of a single year. Their remarkable efforts continue to pay dividends for the Department of Defense (DOD) nearly four decades later in the form of the F-16 Fighting Falcon and the F/A-18 Hornet. The accomplishments of the test force also underscore the important roles of human capital and human agency within the Air Force Test & Evaluation enterprise.

BACKGROUND

Fighter Requirement

The Air Force's experience in Vietnam highlighted its need for a highly maneuverable fighter optimized for air superiority missions.[1] During the early days of the conflict, the service utilized the North American F-100 Super Sabre and the Republic F-105 "Thunderchief" as its primary attack and offensive counter air aircraft. As attrition mounted over the course of the conflict, the Air Force and Navy alike turned to the newer and pricier McDonnell Douglas F-4 Phantom II. Originally designed as a long-range interceptor, the Phantom relied on air-to-air missiles to engage enemy aircraft from beyond visual range. It struggled, however, to compete with smaller, lighter, and less sophisticated Soviet-built aircraft such as the MiG-17 and MiG-21 in close aerial combat.[2] The Air Force attempted to bolster the F-4's dogfighting capabilities by adding an internal M61 Vulcan rotary cannon to later models, but the loss of 36 Phantoms to enemy MiGs between 1965 and 1972 persuaded Air Force leaders that a more capable air superiority fighter was desperately needed.[3]

Internal Debates

While most within the Air Force agreed on the need for a new fighter, disagreements over design philosophies and acquisition strategies quickly coalesced into competing agendas. On one side of the debate, a majority of Air Force decision-makers believed that the service should invest in a new high-cost, high-tech, multi-role fighter. They prioritized top speed and sophisticated weaponry. On the other side of the debate, a small but determined group challenged those prevailing dogmas so relentlessly

that it earned the moniker "Fighter Mafia." They focused instead on acceleration and turning performance, and argued that the Air Force could enhance its air combat capabilities by investing in a lower cost, purpose-built air combat fighter less reliant on expensive new technologies.[4]

The Fighter Mafia did not shy away from confrontation or controversy in promoting their views. Members of the group included outspoken individuals such as Charles "Chuck" Myers, a former Navy and Air Force test pilot who became the Pentagon's director for air warfare; Maj John R. Boyd and Pierre Sprey from the DOD Systems Analysis Office; test pilot Col Everest Riccioni; mathematician Thomas P. "Tom" Christie; and aeronautical engineer Harry J. Hillaker. They strongly believed that scientific evidence supported their arguments. Specifically, the Fighter Mafia appealed to Energy-Maneuverability (EM) Theory to make their case for a lighter, cheaper fighter.

Major Boyd and Tom Christie jointly developed EM Theory to assess aircraft maneuverability. Their methodology utilized physics to evaluate the potential energy, kinetic energy, and turn rate of an aircraft.[5] Boyd and Christie's quantitative analysis seemed to favor more nimble fighter designs, but the traditionalists' did not completely concede to the Fighter Mafia's radical ideas or brash criticism. Consequently, the newly established F-15 program focused more on top speed and advanced weaponry than acceleration and turning radius. This resulted in a larger, heavier, and more costly fighter.[6] Undeterred by their failure to coopt the F-15 program, the Fighter Mafia persuaded the Office of the Secretary of Defense to begin a formal study of EM Theory in 1970.[7] Their ultimate goal remained the acquisition of a low-cost, lightweight fighter for the Air Force. Human agency would continue

to preserve and perfect the concept until another opportunity to promote it emerged.

Escalating Controversies

Following a series of expensive procurement programs profiled by the media, Congress, and the American public questioned whether DOD's acquisition programs adequately prioritized value. Escalating costs, lengthy schedule delays, and frequent technical problems associated with programs such as the F-111 generated considerable skepticism. The F-111 program initially promised roughly $1 billion in savings to DOD but wound up costing the department that much in losses.[8] Distrust of DOD's acquisition practices in turn raised questions over the viability of the Navy F-14 and Air Force F-15 programs.[9] A Blue Ribbon Defense Panel commissioned by President Richard M. Nixon and Secretary of Defense Melvin R. Laird in 1969 undertook a review of DOD's policies and practices.[10] Defense acquisition received considerable attention from the panel. The panel concluded that the "frequency and magnitude" of the problems it identified pointed to underlying mismanagement.[11]

The panel's report strongly objected to DOD's total package procurement model, which pursued concurrent development and production of weapon systems under the auspices of a government contract. Citing a need to evaluate systems before the government committed to purchasing them, the panel called for a prohibition of total package procurement and advocated competitive prototyping as a means to reduce financial risks.[12] Specifically, the panel contended that competitive prototyping would allow the government to identify unanticipated problems with new technologies, new performance areas, and design

oversights.[13] Their report would serve as the impetus for DOD's subsequent forays into competitive prototyping.

Prototype Study Group

The findings of the Blue Ribbon Defense Panel closely aligned with the personal views of Deputy Secretary of Defense David Packard. Secretary Packard favored a "fly before buy" approach to acquisition, and in the summer of 1971 announced that DOD would allocate $200 million towards competitive prototyping programs.[14] In order to maximize the service's percentage of that distribution, General John C. Meyer, Vice Chief of Staff of the Air Force, organized an Air Force Prototype Study Group in June 1971.[15] The study group outlined the service's rationale for prototyping, decided what to prototype, and determined how best to manage a prototype program.[16] Participants included representatives from Headquarters Air Force, Air Force Systems Command (AFSC), and the Air Force Laboratories.

The study group affirmed the feasibility and desirability of an Air Force Advanced Prototype Program as a further evolution of DOD's new fly-before-buy acquisition philosophy.[17] Members recommended the program focus primarily on advancing technologies relevant to current and future military needs by utilizing prototype hardware demonstrations.[18] Additionally, the study group called for streamlining the Air Force's management and procurement processes for competitive prototyping efforts by minimizing documentation and reporting requirements, simplifying development approaches to reduce costs, emphasizing design goals over military specifications, and tailoring performance measurements and evaluations to the program.[19] Anticipating fierce

competition for resources, the Prototype Study Group focused its attention on potential projects that already demonstrated a certain degree of technical maturity. Because of the EM studies previously approved by the Office of the Secretary of Defense (OSD), the lightweight fighter proposal met this standard.

Program Concept

The Prototype Study Group's project selection team characterized the Lightweight Fighter Prototype Project as a feasibility demonstration of a low cost air superiority aircraft optimized for the transonic/medium altitude combat arena.[20] Their proposal called for two contractors to produce two prototypes each that would combine advanced technologies with aircraft designs inspired by EM Theory. In keeping with the prototype program philosophy, the contractors would develop the systems and the Air Force would subsequently evaluate them.[21] The conspicuous omission of a guaranteed full-scale production contract at the conclusion of the program muted objections from detractors who feared that a lightweight fighter could potentially undermine funding for the pricier F-15 program.

In addition to considering aircraft performance goals, the study group also weighed options for tailoring a test program to competitive prototyping. By the late 1960s, aircraft testing had evolved into a three-category effort. During Category I flight test, contractors verified the aircraft's basic capabilities and safety when operating within the flight envelope. The Air Force Flight Test Center (AFFTC) then evaluated the aircraft's flying qualities and systems on behalf of the Air Force during the Category II flight test. The using command subsequently evaluated

the aircraft's operational suitability as part of the Category III flight test. In order to simplify the effort, the study group proposed combining the three individual flight test categories into a single, three-phased program.[22]

The modified test concept called for a loose division of program responsibilities between the contractors, AFFTC, and Tactical Air Command (TAC). Each would contribute to the development of a detailed test plan and participate in every phase of the program. The contractors would take the lead in developmental testing and provide support throughout the program. A team from AFFTC would evaluate the performance and flying qualities of the prototypes. An additional team from TAC would focus their efforts on investigating the prototypes' operational potential.[23] A member of the AFFTC contingent would serve as the test director. The relaxed requirements for formal data and reports would require more hands-on involvement and face-to-face interaction from everyone involved in the program.

The project selection group presented its recommendations to Secretary Packard on August 5, 1971. The LWF was the first of the six proposals he approved. ASD subsequently established a small Prototype Program Office (PPO) at Wright-Patterson Air Force Base (AFB), Ohio, on August 27, 1971. Col Lyle Cameron served as the PPO's first director. In that capacity, he maintained overall management of the new program.[24]

After evaluating the prototyping proposal, AFFTC personnel recommended prioritizing early tester involvement. This would allow AFFTC to outline project office and engineering responsibilities in advance, and assign those duties to specific individuals immediately

after the award of a prototype contract. Early involvement would also allow AFFTC to adjust its test plans and test force structure according to contractor capabilities. If the selected contractors utilized experienced test pilots, AFFTC planned for equal contractor and Air Force participation in the program. However, if the contractors provided only "minimally qualified" personnel, AFFTC argued in favor of relying "heavily or entirely" on the cadre of Air Force test pilots.[25]

Lightweight Fighter Prototypes

The Air Force issued a Request for Proposals (RFP) to nine aerospace firms in January 1972 to solicit the design and construction of a lightweight fighter that embodied EM theory for technology demonstration purposes.[26] In keeping with the new emphasis on performance goals and administrative efficiencies, the RFP was significantly shorter than similar products submitted under DOD's previous procurement model.[27] The RFP detailed the design goals established by the PPO, and though it did not call for a follow-on manufacturing effort, the program targeted a $3 million cost per unit assuming a hypothetical production run of 300 aircraft over 3 years.[28]

The Air Force abbreviated the source selection process by limiting the amount of information required from the respondents and curtailing the amount of time to select the prime contractors. The Air Force also limited the length of contractor proposals to 50 pages of technical data along with 10 pages of cost justifications.[29] The condensed format stood in stark contrast to earlier submissions that routinely extended to 250 pages.[30] In addition to the proposal itself, the contractors would provide wind tunnel data and scale models of their prototype concepts.

The Air Force would use those models in what amounted to a wind tunnel competition to substantiate the data provided in the proposals.[31]

Five contractors submitted six proposals. Boeing, General Dynamics, Lockheed, and Ling-Temco-Vought (LTV) each provided single-engine prototype plans. Northrop submitted both a single-engine and a twin-engine design for consideration. On April 13, 1972, Air Force Secretary Robert C. Seamans, Jr., announced the selection of General Dynamics Corporation and the Northrop Aircraft Division to develop prototype lightweight fighters.[32] On the heels of that announcement, the Air Force reiterated that no direct fly-off competition between the two airframes had been scheduled.[33] In spite of the service's insistence that there was no operational need or plan for a lightweight fighter, the program quickly generated interest at home and abroad.

General Dynamics unveiled the first of its two YF-16 prototypes in a ceremony at its plant in Fort Worth, Tex., on December 13, 1973. The single-engine, single-tail YF-16 was 47 feet long with a wingspan of 30 feet. It weighed roughly 22,000 lbs. with internal fuel, an M61 gun, and two AIM-9 missiles. The YF-16 utilized the Pratt and Whitney F-100 turbofan engine, which could generate over 25,000 lbs. of thrust.[34] In order to achieve the desired performance characteristics for the LWF, General Dynamics engineers combined aerodynamic concepts influenced by EM Theory. Notable aircraft features included a blended wing-body intersection, an underslung engine inlet, a one-piece windshield and canopy, a 30-degree seat back angle, a right console-mounted control stick, and an analog fly-by-wire flight control system to augment stability.[35] Without the latter, the YF-16 would not have been flyable at

subsonic speeds because its center of gravity was aft of its aerodynamic center.[36]

The twin-engine YF-17 design was larger than the YF-16 at 56 feet long with and a wingspan of 38 feet. It weighed approximately 23,000 lbs. with internal fuel, an M61 gun, and two AIM-9 missiles. The YF-17 relied on two General Electric YJ-101 engines, which could produce a combined thrust of over 28,000 lbs. Engineers at the Northrop facility in Hawthorne, Calif., incorporated several design elements to meet the demands of EM Theory. Features included a large leading edge extension, maneuvering flaps, twin tails for directional stability, a cockpit designed for increased "g" tolerance, and an integrated wing/engine inlet to enhance flight characteristics under difficult conditions such as low airspeed, high altitude, large yaw rates, and high angle of attack conditions.[37] Northrop would not debut the first of its YF-17s until April 1974.

TEST PREPARATIONS

Structuring the Test Force

As construction of the winning prototypes commenced in Fort Worth and Hawthorne, the job of establishing the program's test force began at Edwards AFB. The non-standard structure of the test program prompted the establishment of an equally unique and integrated test organization comprised of Air Force, contractor, and National Aeronautics and Space Administration (NASA) personnel.

Contractor test pilots would conduct airworthiness and flight envelope tests with an emphasis on flight loads, flutter, and structural demonstrations. Air Force pilots in turn would carry out performance testing. Test Management Councils would provide overall direction to the individual test programs. The PPO director would serve as the chair for both councils with senior Air Force and contractor representatives serving as members. Contractor representatives would function as the Vice President and Program Manager of the councils.[38]

Headquarters AFSC designated AFFTC as the Air Force's Responsible Test Organization (RTO) for the LWF Program. In turn, AFFTC appointed Lt Col James R. Rider as director of the LWF JTF.[39] Lieutenant Colonel Rider's initial involvement with the program came about inadvertently.[40] A graduate of Aerospace Research Pilot School (ARPS) Class 65-C, Lieutenant Colonel Rider served on the ARPS faculty prior to a combat tour in Southeast Asia flying F-105s. *He subsequently returned to Edwards AFB as part of the fighter division under Test

Operations (Test Ops). There Lieutenant Colonel Rider oversaw several smaller scale fighter-related test programs. His superiors presumed the lightweight fighter would simply be more of the same and named him the project manager.[41] His responsibilities quickly progressed from simple administrative matters to participating in prototype source selection at Wright-Patterson AFB.[42]

Familiarity with the program, coupled with combat and flight test experience, ideally suited Lieutenant Colonel Rider to the test director role. In that capacity, he would ensure both contractors had equal opportunities to demonstrate the capabilities of their prototypes. He also initiated early tester involvement. Lieutenant Colonel Rider and senior members of the new JTF interfaced with the two contractors early and often to monitor progress and familiarize themselves with the prototypes. This hands-on approach required numerous trips to contractor facilities to meet with the design engineers who developed the respective systems.[43]

To encourage independent thinking and ingenuity, contractor representatives would work in separate integrated test teams (ITTs) alongside Air Force and NASA personnel. A smaller group of engineers and pilots unified the effort by assessing both aircraft. Lieutenant Colonel Rider, Maj Robert C. Ettinger, and Maj Michael C. Clarke would serve as AFFTC's test pilots. Major Ettinger would primarily fly the YF-16 while Major Clarke focused mainly on the YF- 17. Lieutenant Colonel Rider planned to fly both aircraft throughout the course of the program.

The AFFTC pilots brought a high degree of experience and enthusiasm to the program. Major Ettinger described it as a fighter pilot's dream.[44] He had recently earned a Master of Science degree in Aeronautical Engineering

from The Ohio State University. Prior to this, the veteran F-4D combat pilot successfully completed ARPS (Class 68-B) and worked with the Fighter Branch of the 4950th Test Wing at Wright-Patterson AFB. Major Clarke earned several decorations during his time in Vietnam, including the Distinguished Flying Cross, the Meritorious Service Medal, thirteen Air Medals, the Purple Heart, and three Republic of Vietnam Crosses of Gallantry. After attending ARPS (Class 67-B), Major Clarke remained at Edwards AFB to work in Test Ops.

Experienced flight test engineers from AFFTC supported both test teams as well. Like the pilots, engineers brought a significant amount of passion to the program. James A. "Jim" Papa, a YF-16 ITT flying qualities engineer, described his role in the program as "the best job that a person could have."[45] Frank Lucero, a fellow engineer with the YF-16 ITT, observed that, "We weren't doing it for the SPO (systems program office). We weren't doing this for the contractors. We were doing it for our warriors."[46]

The TAC pilots divided their workload in a manner similar to the AFFTC pilots. Their team included Lt Col Maurice B. "Duke" Johnston, Maj Rutherford "Dean" Stickell, and Maj Joseph W. "Joe Bill" Dryden. All were veteran combat pilots, but none had completed any test pilot training prior to their participation in the LWF Program. Major Stickell would concentrate on the YF-16 while Major Dryden focused on the YF-17. Like Lieutenant Colonel Rider, Lieutenant Colonel Johnston would fly both the YF-16 and YF-17.

The respective contractors also supplied their own personnel. Philip F. "Phil" Oestricher and Neil Anderson of

General Dynamics flew the YF-16. Northrop selected test pilots Henry "Hank" Chouteau and Joe Jordan to pilot the YF-17.

In addition to pilots and engineers, the JTF also leveraged the expertise of AFFTC's enlisted corps. Three non-commissioned officers oversaw general, avionics, and engine maintenance of both prototypes, and offered recommendations for improving their overall maintainability.[47] According to Lieutenant Colonel Rider:

> *They were an integral part of the team. There weren't just flight test engineers and test pilots. The enlisted group we had working with us were absolutely superior. The thing is there were only three of them! They split their time between looking at both airplanes.*[48]

Developing the Test Plan

Drafting a test plan represented the first significant challenge for the JTF. No organization had previously composed a single test plan for two ITTs. The Combat Relevant Tasks would serve as the primary focus for both ITTs. According to Richard R. Hildebrand, Lead Engineer for the YF-17 ITT, the program "had a very simple set of requirements, and the idea was to let the contractors show what they could do. The requirements didn't change."[49]

Lieutenant Colonel Rider recalled his team met "ad nauseum" with representatives from General Dynamics and Northrop to compose a detailed, flight-by-flight plan for the entire 300 hours of the test program.[50]

We basically locked ourselves in little cubicles with the contractors, the flight test center people, and the TAC people. We lined the walls of the room with butcher paper, started with flight #1, and made detailed flight test plans. We fully realized that we probably wouldn't fly the plans exactly as written, but those plans would get us to the end of the program having flown sufficient time against each task. In the end, we would have a good understanding of the capabilities of each airplane against those tasks. were an integral part of the team. There weren't just flight test engineers and test pilots. The enlisted group we had working with us were absolutely superior. The thing is there were only three of them! They split their time between looking at both airplanes.[48]

Lightweight Fighter Combat Relevant Tasks
Aircraft Configuration
– Full internal fuel – Two AIM-9E missiles – 500 rounds of 20 mm ammunition
Mission Profile
– Four sustained turns at 30,000 ft. and 0.9 Mach – Three sustained turns at 30,000 ft. and 1.2 Mach – Acceleration from 0.9 to 1.6 Mach – Expend AIM-9E missiles and 50% of ammunition – Climb from 20,000 ft. to optimum cruise altitude – Cruise at optimum altitude and Mach for 500 nm – Retain fuel reserve for 20 minute loiter at sea level

Discussions with General Dynamics and Northrop proved easy and fruitful due to the amount of

administrative latitude provided to the JTF by the PPO, and the early involvement of flight test professionals. This produced a dynamic of "total cooperation" during the design and planning phase of the test program.[52] Jim Papa from the Y-16 ITT remarked:

> *We not only cooperated on the test program itself, we worked with the contractors to try and come up with common approaches to the flight test techniques and analysis so there would be some sense of commonality when we came to evaluate the airplanes. Even though we weren't sharing things about each contractor's airplane, we were talking a lot about how we were going to put the analysis together so that you wouldn't come up with things that were apples and oranges.*[53]

Mindful that one of the prototypes could generate interest for further development, AFFTC planners expanded the scope of the test plan to include systems and aerodynamics evaluations.[54] The top priority remained assessing the performance of the aircraft in relation to the required Combat Relevant Tasks. However, the JTF would also collect and evaluate additional data of potential value to a follow-on program.[55]

An abbreviated schedule meant that each ITT needed to complete its program within 12 months.[56] In order to minimize potential delays, the JTF maintained the authority to approve minor changes to the test plan. Major changes required the approval of the TMC.[57] The contractors in turn established the pace for their respective programs and scheduled flights accordingly. This concession would result in overlapping but not completely concurrent test

efforts given that General Dynamics was further along in its development of the YF-16 than Northrop was with its YF-17.

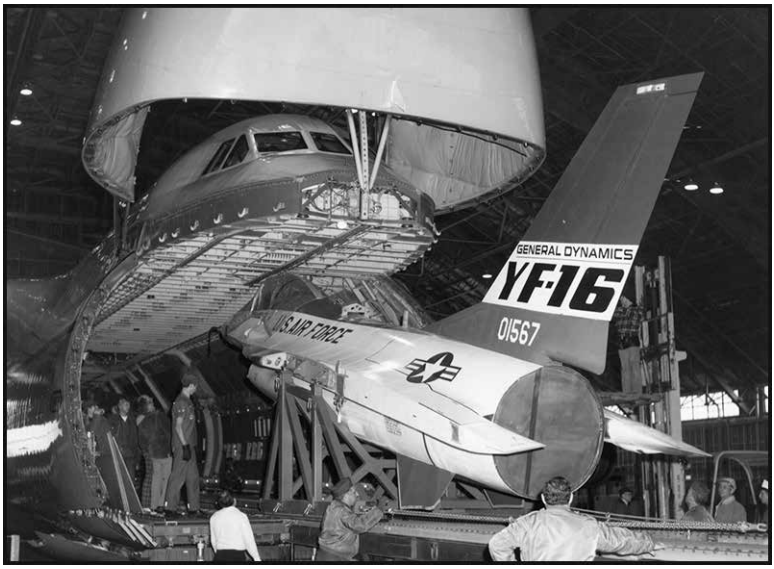
The test plan called for contractor, AFFTC, and TAC pilots to share the program's 300 hours of flight time equally. The ITTs would integrate even further by allowing the pilots to fly missions interchangeably rather than observe a strict adherence to phase-related roles. This in turn would allow the teams to test multiple systems simultaneously and utilize the aircraft more efficiently.[58]

In order to implement this innovative strategy, however, Lieutenant Colonel Rider would first need to address the status of the JTF's TAC personnel. The fact that they had not attended ARPS raised some concerns over their participation at the AFFTC level. Lieutenant Colonel Rider, drawing on his own experience as a former ARPS, addressed the concerns by providing ad hoc flight test training to the TAC pilots. He recalled the decision initially upset certain individuals at AFFTC, but he exercised his administrative autonomy to broaden the skills of his pilot team informally.[59]

TEST PROGRAM

Starting the Test Program

The first YF-16 prototype arrived at Edwards AFB from General Dynamics on January 8, 1974, aboard a C-5 Galaxy transport. Its maiden flight at Edwards AFB on January 20, 1974, came as something of a surprise. During a high-speed taxi test, General Dynamics pilot Phil Oestricher encountered roll oscillations that caused the right horizontal stabilizer to drag along the runway. Rather than risk damaging the YF-16 in an attempt to stop it from going airborne, Oestricher chose instead to take flight.



YF-16 #1 arrives at Edwards AFB from Fort Worth, Tex., on January 8, 1974. (USAF Photo by SSgt Howard G. Divers, Jr.)

Lieutenant Colonel Rider had previously presented the take-off option to Oestricher in the event of a problem.[60] When word of the YF-16's unexpected takeoff reached AFFTC leadership, Lieutenant Colonel Rider received a call from Col James Wood, the 6510th Test Wing commander. He suggested that perhaps Oestricher should make two long approaches to see how the aircraft performed. Lieutenant Colonel Rider countered that he ought to land as soon as possible. Colonel Wood deferred to him, and Oestricher made a normal landing after 6 minutes of flight. General Dynamics subsequently added a rheostat to the YF-16, which enabled the pilots to adjust flight control settings and reduce the risk of roll oscillations during takeoffs and landings.[61]

YF-16 #1 in Flight Over Edwards AFB. (USAF Photo)

YF-16 testing accelerated the following month. Lieutenant Colonel Rider piloted the first prototype during its initial Air Force flight on February 2, 1974. General Dynamics subsequently delivered the second YF-16 prototype to the JTF on February 27, 1974. Testing temporarily came to a halt for three days that month when the YF-16 ITT identified engine fuel-control anomalies. The problem reappeared during Captain Stickell's initial flight in the YF-16 on March 25, 1974.

> *On my first flight, I climbed into the airplane, took off, climbed up to 15,000 feet, and pulled the throttle to idle. When I pushed back up the middle, nothing happened. It stayed in idle. You can bet I was surprised. I went home that evening thinking, "Flight test is full of surprises! It's really exciting!"*[62]

Following Captain Stickell's subsequent emergency landing, the ITT subsequently suspended YF-16 flights for 3 weeks to examine the problem. Their investigations revealed that high fuel temperatures and fuel contamination contributed to the engine malfunction. Fuel-control unit modifications allowed flights to resume, but the issue resurfaced later in the program.[63]

As the YF-16 test team entered their fourth month of testing, the YF-17 test team prepared for the start of their test effort. Northrop revealed the first of its two YF-17 prototypes on April 4, 1974, at its factory in Hawthorne. They subsequently delivered it to Edwards AFB by truck on April 23, 1974. Before the JTF could commence work with the YF-17 in earnest, however, they had to adapt to a new charter.

Shifting the Test Focus

As the technology demonstration progressed at Edwards AFB during the spring of 1974, the political winds in Washington D.C. shifted in favor of full-scale development of the LWF. While Air Force leadership continued to state that the effort was merely a technology demonstration rather than an acquisition program, the Secretary of the Air Force established a Tactical Fighter Modernization Study Group to assess the service's force composition. Though dubious of the LWF, Air Force leaders recognized that they would not be able to purchase sufficient quantities of F-15s to meet mission requirements. This realization persuaded them to consider the pragmatism of a "high-low" fighter mix that included both the F-15 and a lightweight fighter.[64]

Growing interest in the LWF Program by European nations seeking to replace their aging F-104 fleets served as an additional incentive for the Air Force to invest in a second fighter. In the end, the establishment relented. Secretary of Defense James R. Schlesinger announced his decision on April 29, 1974. He ordered the LWF Program to transition into a direct competition between the YF-16 and YF-17 to become the Air Force's new Air Combat Fighter.[64]

AFFTC believed a competitive fly-off would require more test personnel than a technology demonstration.[65] The shift to a fly-off also came as something of a shock to members of the JTF, especially to those assigned to the YF-17 test team. Col James H. Doolittle III (USAF, Ret), then a first lieutenant and an YF-17 Systems Project Engineer, commented:

> *You should have seen our faces the morning that our bosses walked in and said, "Hey guys. We've got some new direction. This isn't a technology demonstration. This is a fly-off." The sense of urgency got really, really big.*[66]

The acceleration of the program resulted in additional pressures on the JTF. Not only did its personnel have to compensate for a compressed timetable, they also had to contend with the demands of visiting political and military leaders and sudden changes of schedule. Acceleration also increased the number of visits to the PPO at Wright-Patterson AFB, AFSC Headquarters at Andrews AFB, Md., and the Pentagon. These trips would eventually culminate in presentations to a Source Selection Evaluation Board and Source Selection Advisory Council. In the interim, test efforts would continue in spite of the new responsibilities that took key personnel away from conducting flight tests.[67]

While JTF leadership focused on the program's reorientation, their personnel concentrated on test execution and problem solving. The YF-16 fuel-control problem that appeared in February and March resurfaced again on May 16, 1974. As Lieutenant Colonel Rider pulled up from a practice landing approach, the engine of his YF-16 stopped responding to his inputs. Stuck at idle thrust at low altitude, Lieutenant Colonel Rider was forced to make an emergency landing on the lakebed.[68]

> *I knew that the engine wasn't going to respond, so I was going away from all of the landing places out there. I flew it right across the top of the hangars there on Contractor's Row, so the only land-able place there was right back behind me. So, I turned around and landed there. I had enough speed to pull up and do that.*[69]

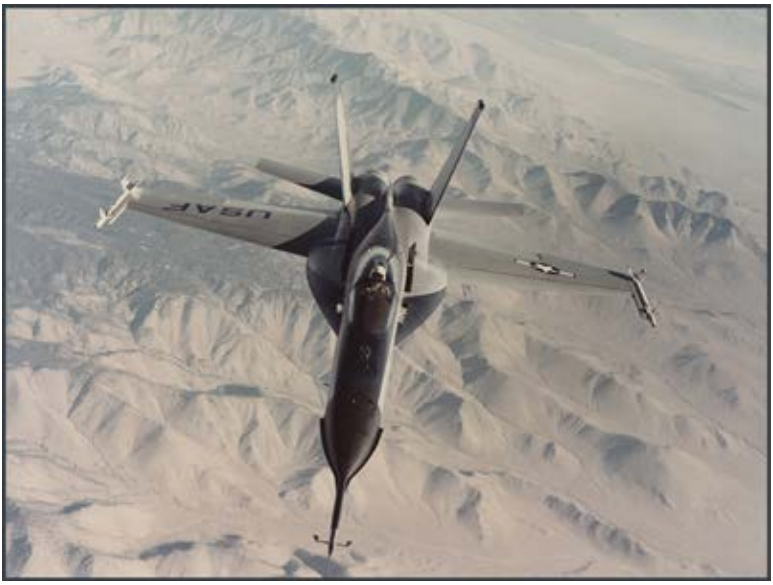
An 11-day suspension of YF-16 flights followed the incident, but the ITT took interim steps to resume testing until they could implement a permanent fix. They

temporarily restricted flights to specific geographical and altitude boundaries near Edwards AFB. General Dynamics engineers temporarily installed a rheostat that enabled the pilots to adjust thrust settings up to 5000 lbs. to ensure a safe return to base. Further investigations revealed fabrication-related metal contamination in the fuel-control unit, which prompted another modification to the YF-16.[70]

By the end of June 1974, the two YF-16 prototypes had completed 102 flights for a total of 105.2 hours of flying time. Of those flights, General Dynamics pilots accounted for 49, AFFTC pilots 30, and TAC pilots 23.[71] They completed all basic aircraft and systems checkout flights and accomplished several test points. The ITT's pilots had successfully qualified in the aircraft and adapted to it very quickly. They typically took the prototype to supersonic speeds by their third flight.[72]

The YF-17 team got their test program underway on June 9, 1974, when Northrop pilot Hank Chouteau took the Cobra on its maiden flight.[73] The following day Chouteau reached Mach 1.1 in the YF-17 without the use of afterburner, the first time a U.S. plane had ever done so in level flight. Lieutenant Colonel Rider undertook the first Air Force flight of the prototype on June 18, 1974. The previously announced shift to a formal competition took place soon thereafter in July 1974. Further changes would follow.

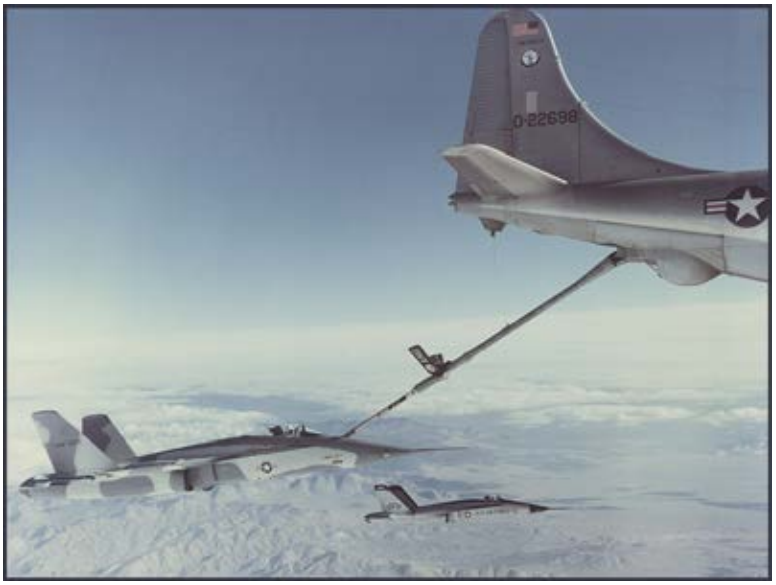
Lt Col James G. Rider, Director,
Lightweight Fighter Joint Test Force (USAF Photo)



YF-17 #1 in flight over the Mojave Desert. (USAF Photo)

Under pressure from the Office of the Secretary of Defense, the Air Force accelerated the test program to support European Participating Governments fighter procurement. These developments led to an increased emphasis on the operational evaluation portion of the test program and greater involvement from the new Air Force Test & Evaluation Center (AFTEC). Under the modified test plan, the prime contractors continued to conduct developmental test of their respective prototypes while providing maintenance and logistics support for their aircraft. AFFTC retained program management responsibility and conducted tests of aircraft performance, flying qualities, and systems evaluation in addition to data reduction and flight test support. TAC maintained responsibility for operational test and evaluation of the prototypes with assistance from AFTEC. Finally, the Air

Force Logistics Command evaluated aircraft reliability and maintainability.[74]



YF-17 #1 and #2 receive fuel from a Wisconsin Air National Guard KC-97. (USAF Photo)

The changes posed a particular challenge for Northrop, which would no longer have a full year to develop its YF-17 prototypes. As a result, the JTF had to make significant adjustments to its test plan in order to accelerate testing of the YF-17. The resulting schedule shift made for more complicated logistics. In order to meet the new timelines established by the Air Force, Lieutenant Colonel Rider had to solicit tanker support from the Air National Guard. A KC-97 unit in Texas organized the response. The JTF subsequently welcomed tankers from as far away as Massachusetts.

At any one time, Edwards AFB had up to three KC-97s on its ramp. They aided test acceleration by refueling the

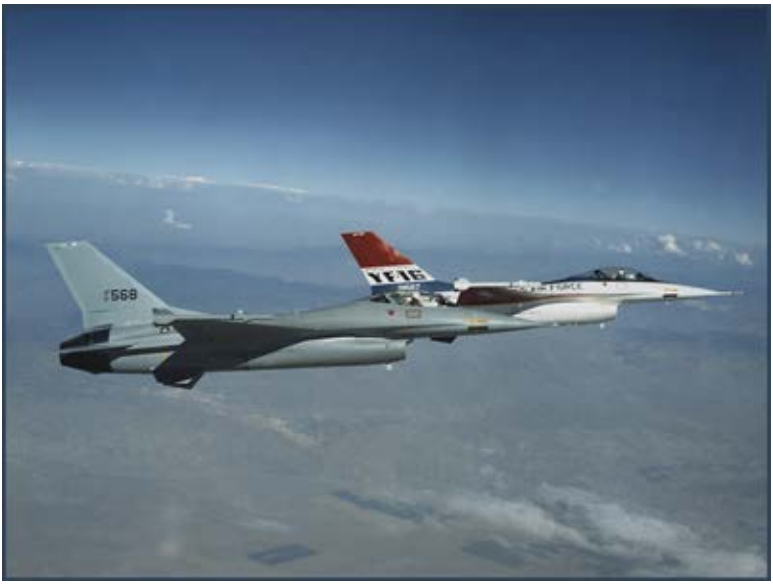
YF-17 prototypes between 12-15 times per day.[75] While the YF-17 team was the primary beneficiary of the KC-97 support, the YF-16 utilized it as well. As a result, the JTF could fly each portion of the Combat Relevant Task on both aircraft, in the same airspace, on the same day.[76] Without this support, it is doubtful that the program would have kept pace with the aggressive new test schedule.

As the competition progressed, the JTF's pilots and engineers spent a considerable amount of time in late afternoon and evening discussions weighing the pros and cons of what they had observed during the day.[77] These conversations not only resulted in material improvements to the two prototypes, but also introduced innovations within the flight test enterprise itself. The JTF utilized a Boeing 747 inertial navigation system (INS) to measure angles and rates during its test flights, which allowed for quick data analysis and dissemination. A task that once required weeks was now immediately accessible to flight test engineers. This innovation represented a significant process evolution for AFFTC. So too did the extensive use of Digital Performance Simulation (DPS), a computer program that simulated aircraft performance. AFFTC first utilized DPS during the YA-9/YA-10 test program, but the JTF expanded its usage to evaluate the performance of the prototypes against the Combat Relevant Task.

Scrutinizing the Test Results

As the test program ended in January 1975, AFFTC and briefings to the Source Selection Evaluation Board and Source Selection Advisory Council. Lieutenant Colonel Rider and Lieutenant Colonel Johnston received five minutes each to discuss their findings. They focused

their presentations on the maneuverability, acceleration, deceleration, combat sustainability, and combat endurance of the competing prototypes.[78]



YF-16 #1 and #2 in flight. (USAF Photo)

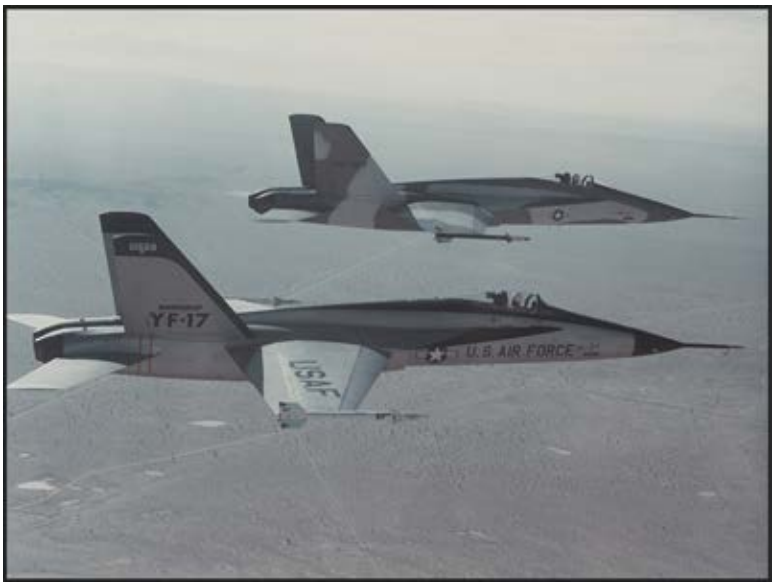
In general, the YF-16 performed better than General Dynamics predicted. The flight control system required a significant amount of fine-tuning early in the program, but engineers quickly adjusted the aircraft's fly-by-wire controls.

> *We used a lot of simulation in order to develop the flight control system. Since we had the analog system based in the simulator, we could do a flight, find deficiencies, receive corrections from General Dynamics engineers, have the technicians make changes to the flight control computer, conduct a safety review, and fly the changes, sometimes the very next day.*[79]

The innovative angle of attack and load factor limiter of the YF-16 also operated well after some improvements. Several engine problems emerged during the test including a limited flight envelope for afterburner ignition, engine lag during acceleration, and engine RPM sticking at idle. Subsequent corrections provided safer operation for a single-engine fighter.

The YF-16 had no significant engine issues specifically related to flying at a high angle-of-attack. However, the aircraft exhibited poor departure and spin resistance when rolling at high angles-of-attack. Other problems included directional stability with heavy load factors and inadequate brake energy capacity. The aircraft exhibited high reliability and low requirements for both scheduled and unscheduled maintenance. On one occasion, YF-16 No. 1 flew six flights in one day. The AFFTC Performance Evaluation Report on the YF-16 stated, "The YF-16 accomplished all of the objectives and exceeded the performance requirements specified in the original Request for Proposal."[80] The technologies and innovations incorporated in the YF-16 design produced a significant advancement in fighter aircraft performance.

Although the YF-17 failed to achieve some of Northrop's performance predictions, it nevertheless demonstrated performance and energy maneuverability superior to any existing fighter aside from the F-15. The prototype General Electric YJ-101 engines proved highly reliable and almost trouble-free. The YF-17 flew fewer flights than the YF-16, but the average flight length was longer because it utilized in-flight refueling more often. The YF-17 demonstrated good flying qualities, low speed maneuverability, and high levels of departure resistance except for departure tendencies during sideslip testing.



YF-17 #1 and #2 in flight. (USAF Photo)

The YF-17 exhibited minimal limitations with respect to angle of attack, control usage, or power manipulation. Although it entered the high angle of attack region often, it suffered no loss of control. Major problems with the YF-17 included the loss of two canopies, fuel cell ruptures, and a lag in the flight control system that adversely affected high gain tasks. The YF-17 displayed excellent subsonic lift and thrust-limited turning performance.

There were pros and cons associated with each airframe. The YF-16 was a more difficult airplane to fly. According to Lieutenant Colonel Rider, "You had to fly the YF-16 all the time. You had to fly it all the way to the ground because you were landing it at a speed that it would like to still fly."[81] As for the YF-17, he quipped, "You could put your daughter in it and it would go fast. It was a piece of

cake!" In the end though, the JTF concluded that the YF-16 had the tactical advantage of being able to accomplish all of the Combat Relevant Tasks where the YF-17 could not. The source selection board agreed. Officials declared the YF-16 the winner of the competition on January 13, 1975, and awarded General Dynamics a full-scale development and production program for the Air Force and European allies. The LWF JTF's pilots, engineers, and maintenance personnel subsequently served as the core for a highly successful F-16 program. Though Northrop did not prevail in the LWF contest, its YF-17 prototype generated significant interest from the Navy and eventually led to the development of the F/A-18.

OBSERVATIONS

Summary of Successes

The LWF Prototype Program facilitated two of the most significant fighter acquisition programs in military aviation history. The USAF and the air forces of 26 other nations collectively procured 4,535 F-16s.[82] Program observers such as the U.S. Navy, Marine Corps, and the forces of seven other nations subsequently acquired 2,107 F/A-18s developed from YF-17 design concepts.[83]

The effort also quickened the pace of technological evolution within military aviation. Advances such as fly-by-wire flight control systems, relaxed pitch axis stability, and leading-edge maneuvering flaps would have come about either way, but experts contend that they "would have occurred far more slowly, one at a time" if not for the LWF Prototype Program.[84] Successful demonstrations of these systems led to their incorporation into later programs such as the F/A-18 and F-117A.[85]

The LWF JTF itself demonstrated the viability of an integrated developmental and operational testing strategy. The test force's successes validated a collaborative approach to test planning and execution and demonstrated the advantages integrating contractor, developmental, and operation test efforts. Furthermore, the scope of the changes and challenges encountered by the JTF underscores the importance of flexible, tailored test programs.[86]

Key Factors of Success

The success of the LWF Program did not hinge on the soundness of competitive prototyping strategy alone. The efforts and expertise of the test professionals who planned

and executed the program translated its potential value into actual value. Without their contributions, the return on investment for both the Air Force and DOD might have been far less. The key factors that enabled the men and women of the LWF JTF to maximize the value of the program included experience, cooperation, autonomy, and ingenuity.

The JTF drew from a wealth of Developmental Test & Evaluation experience. Half of the organization's pilots completed ARPS. All had flown in combat. The TAC pilots who did not have a background in flight test received on-the-spot training from the test force director, Lieutenant Colonel Rider, who had previously served as an ARPS instructor. A team of veteran engineers carefully scrutinized the prototype aircraft and their innovative systems before and after their arrival. The collective experience of the JTF facilitated the development of a sound test plan, the execution of an efficient test program, and the reorientation of the program with minimal disruption when DOD requirements changed mid-course. Experience also enhanced the organization's capacity for problem solving when technical challenges arose and minimized the JTF's dependence on higher-level oversight.

A cooperative spirit made the JTF's integrated approach to flight test viable. Combining experimental, developmental, and operational tests permitted the early involvement of both the Air Force Test & Evaluation enterprise and the eventual user (TAC). This approach in turn allowed AFFTC pilots and engineers to expedite developmental testing and gave TAC pilots an opportunity to provide feedback on both design issues and flight test activities.[87] None of this would have been possible without a significant amount of cooperation within the test force.

Lieutenant Colonel Rider observed, "I was very, very fortunate as a director to have people from these three different organizations that got along. Now, we didn't always agree, but there was never any disrespect in our disagreements."[88]

According John W. Hicks, a flying qualities engineer assigned to the YF-16 test team, the members of the team worked together as "one seamless team."[89] The same was true for the YF-17 test team. As a result, the JTF successfully compensated for potential disruptions associated with the program's reorientation and completed the test in a minimal amount of time.[90] The integrated test team model subsequently served as the template for a successful F-16 full-scale development flight-test program.[91] Those successes persuaded many in the acquisition community of the merits of integrated testing.

The collective experience and collaborative approach of the JTF empowered the organization to take full advantage of the administrative latitude granted to it by the Prototype Program Office's emphasis on streamlined, adaptive management and simplified reporting procedures.[92] Utilizing a greater degree of autonomy than previous test organizations, the men and women of the LWF JTF structured the program as they thought best to achieve its stated goals within the allotted timeframe. Even when the goals and timetable changed, the JTF successfully reoriented the program with minimal intervention in the organization's day-to-day operations. The Air Force provided the JTF with a charter and then essentially left it to execute that charter as they saw fit.[93]

Tasked with a non-standard test mission, the men and women of the JTF successfully modified test processes in response to the unique needs of the program. Following the reorientation of the technology demonstration into a direct competition, the JTF adjusted to the absences of key personnel and the disruptions of external visitors to provide decision-quality information and enable an early source selection. Their capacity to adapt ensured that the competitive prototyping effort could overcome unexpected challenges and provide exceptional value to DOD, Air Force, and European allies.

NOTES

(All notes appear in shortened form. For full details, see the appropriate entry in the bibliography.)

[1](Adolph and Scrogham, 2014, 144)
[2] (Aaronstein and Piccirillo, 1997, 203)
[3] (Gabbert, 1977, 14)
[4] (Aaronstein and Piccirillo, 1998, 207)
[5] (Hammond, 2001, 59)
[6] (Aaronstein and Piccirillo, 1997, 204-205)
[7] (Coram, 2002, 239)
[8] (Hallion, 1990, 6)
[9](Aaronstein and Piccirillo, 1998, 207)
[10](DOD, 1970, ia)
[11](DOD, 1970, 63)
[12](DOD, 1970, 69)
[13](ASD, 1971, 101)
[14](Coram, 2002, 258)
[15](Geiger, 1977, 2)
[16](ASD, 1971, 1)
[17] (ASD, 1971, 17)
[18] (ASD, 1971, 17)
[19] (ASD, 1971, 4)
[20] (ASD, 1972, 1)
[21] (ASD, 1972, 1)
[22] (ASD, 1971, 10)
[23] (ASD, 1972, 3)
[24](Geiger, 1977, 2)
[25] (Lynch, 1971)
[26] (Geiger, 1977, 6)
[27] Colonel James G. Rider (USAF, Retired), interview by the author, March 11, 2014.
[28](Aaronstein and Piccirillo, 1997, 211)

[29]Rider, interview.
[30](Aaronstein and Piccirillo, 1997, 211)
[31](Rider, 1974, 114)
[32](Air Force Office of Information, 1971)
[33](Air Force Office of Information, 1971)
[34](AFFTC/HO, 1974, 5)
[35] (Oestricher and Anderson, 1974, 119)
[36] (Aaronstein and Piccirillo, 1997, 216)
[37] (Chouteau, 1974, 132)
[38] (Rider, 1974, 114)
[39] (Air Force Office of Information, 1971)
[40] Rider, interview.
[41] Rider, interview.
[42] Rider, interview.
[43] (Hallion, 1998, 39)
[44](Gathering of Eagles, 2014)
[45] (Gathering of Eagles, 2014)
[46] (Gathering of Eagles, 2014)
[47] Rider, interview.
[48] Rider, interview.
[49] (Gathering of Eagles, 2013)
[50] Rider, interview.
[51] Rider, interview.
[52] (Gathering of Eagles, 2014)
[53] (Gathering of Eagles, 2013)
[54] (AFFTC/HO, 1974, 7)
[55] (AFFTC/HO, 1974, 9)
[56] (AFFTC/HO, 1974, 8)
[57] (Aaronstein and Piccirillo, 1997, 214)
[58] (Aaronstein and Piccirillo, 1997, 218)
[59] Rider, interview.
[60] Rider, interview.
[61] (AFFTC/HO, 1974, 14-15)

[62](Gathering of Eagles, 2013)
[63] (AFFTC/HO, 1974, 12-13)
[64] (AFFTC/HO, 1974, 4)
[65] (AFFTC/HO, 1974, 1)
[66] (Gathering of Eagles, 2013)
[67] (AFFTC/HO, 1975, 81)
[68] Rider, interview.
[69] Rider, interview.
[70] (AFFTC/HO, 1974, 13)
[71] (AFFTC/HO, 1974, 13)
[72] (AFFTC/HO, 1974, 13)
[73] (AFFTC/HO, 1974, 13)
[74] (Adolph and Scrogham, 2014, 145)
[75] Rider, interview.
[76] Rider, interview.
[77] Rider, interview.
[78] Rider, interview.
[79] (Gathering of Eagles, 2013)
[80] (Adolph and Scrogham, 2014, 146)
[81] Rider, interview.
[82] (Adolph and Scrogham, 2014, 147)
[83] (Adolph and Scrogham, 2014, 147)
[84] (Aaronstein and Piccirillo, 1997, 225)
[85] (Aaronstein and Piccirillo, 1997, 225)
[86] (AFI 99-103, 2013, 10)
[87] (Aaronstein and Piccirillo, 1997, 213-214)
[88] Rider, interview.
[89] (Gathering of Eagles, 2013)
[90] (Adolph and Scrogham, 2014, 147)
[91] (Adolph and Scrogham, 2014, 147)
[92] (ASD, 1971, 13)
[93] Rider, interview.

BIBLIOGRAPHY

Air Force Instruction (AFI) 99-103. Capabilities-Based Test and Evaluation. 16 October 2013.

Air Force Flight Test Center Project Directive 74-42. "Lightweight Fighter Aircraft Prototype Development Program." 1 November 1973.

Adolph, Charles E. "Pete" and Richard P. Hallion. *A Career in Test and Evaluation: Reflections and Observations* (Maxwell AFB, AL: Air University Press, 1998).

Adolph, Charles E. "Pete" and Wade Scrogham. "Lightweight Fighter Program: YF-16/YF-17 Fly-Off." *The ITEA Journal 35*, June 2014: 144-148.

Aronstein, David C. and Albert C. Piccirillo. "The F-16 Lightweight Fighter: A Case Study in Technology Transition." In *Technology and the Air Force: A Retroactive Assessment*, edited by Jacob Neufeld, George M. Watson and David Chenoweth, 203-227. Washington, D.C.: Air Force History and Museums Program, 1997.

Briefing. Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics. Subject: Implementation of Weapon Systems Acquisition Reform Act (WSARA) of 2009, 22 October 2009.

Chouteau, Henry E. "YF-17 Flight Test Program." *Report to the Aerospace Profession: Eighteenth Symposium Proceedings*. Beverly Hills: Society of Experimental Test Pilots, 1974.

Coram, Robert. *Boyd: The Fighter Pilot Who Changed the Art of War*. New York: Back Bay Books, 2001.

Department of Defense Developmental Test and Evaluation FY 2013 Annual Report. Department of Defense Report, Washington, DC: Deputy Assistant Secretary of Defense Developmental Test and Evaluation, March 2014.

Final Report, USAF Prototype Study. Aeronautical Systems Division (ASD) Report, Wright-Patterson Air Force Base: Air Force Systems Command, 14 March 1972. Document is approved for public release.

Gabbert, Capt Richard D. and Gary B. Streets. *A Comparative Analysis of USAF Fixed-Wing Aircraft Losses in Southeast Asia Combat*. Air Force Flight Dynamics Laboratory Report, Wright-Patterson Air Force Base: Air Force Systems Command, December 1977.

"Gathering of Eagles Panel Discussion" (discussion transcript, Antelope Valley College in Lancaster, CA, October 12, 2013).

Geiger, Clarence J. *History of the F-16: Prototype to Air Combat Fighter, 1971-1975*. Historical Publication, Wright-Patterson Air Force Base: Air Force Systems Command, 1977.

Hallion, Richard P. "A Troubling Past: Air Force Fighter Acquisition since 1945." *Airpower Journal*, Winter 1990. http://www.airpower.maxwell.af.mil/airchronicles/apj/apj90/win90/1win90.htm

Hammond, Grant T. *The Mind of War: John Boyd and American Security*. Washington, D.C.: Smithsonian Books, 2001.

History of the Air Force Flight Test Center, 1 July 1973 - 30 June 1975. Air Force Flight Test Center History Office (AFFTC/HO) Periodic History Report, Edwards Air Force Base: Air Force Flight Test Center, 1974.

Lynch, Maj George P. A-X Project Officer, 6512 Test Group. To Commander, 6510 Test Wing. Memorandum, 5 October 1971.

Lightweight Fighter Prototype Program. Air Force Fact Sheet. Washington, DC: Secretary of the Air Force Office of Information, April 1972.

Preliminary Test Program Concept, Prototype Lightweight Fighter. Lightweight Fighter JTF Paper. Edwards AFB, CA: 6510 Test Wing, 17 January 1972.

Report to the President and the Secretary of Defense on the Department of Defense by the Blue Ribbon Defense Panel. DOD Report. Washington, DC: Department of Defense, 1 July 1970.

Rider, Lt Col James G. "The Lightweight Fighter Program." *Report to the Aerospace Profession: Eighteenth Symposium Proceedings*. Beverly Hills: Society of Experimental Test Pilots, 1974.

APPENDIX A

Interview with Colonel James G. "Jim" Rider (USAF, Ret)

Director, Lightweight Fighter Joint Test Force

By Wade A. Scrogham
Deputy Chief Historian, Air Force Test Center
Conducted on June 12, 2014

Scrogham: Sir, how did you come to be involved in the Lightweight Fighter program?

Rider: It was kind of by accident. I had recently come back from Southeast Asia and was assigned to the fighter division in Test Ops at Edwards AFB. I had been assigned several small programs that came up. One was to verify the stall/flameout boundary on the F-104. The big program was what they called DOD AIMS. We basically had to do pedostatic calibrations. We had computers built for every airplane in the Air Force and Navy inventory to get them corrected so that they were reporting altitude appropriately to new civil air rules and agreements. All of that came about, and this little "snowflake" came across the desk that said something about engines and mentioned a lightweight fighter. It sounded like another little program, so my boss asked me to take care of that. I started answering the mail. All of the sudden it became more than an engine program. The contractors were asked to put together very abbreviated proposals. We put together a team, mainly out of Wright-Patterson and other places, to evaluate these proposals. Those proposals were for the lightweight fighter program, and that basically substantiated it. We got a program started. I wound up on

that source selection as part of the flight test committee. The proposals were all limited to 50 pages, so I read all of them all in one day. Normally when contractors submit proposals, they send them up in a truck. We didn't have to deal with that. We basically allotted 2 weeks to evaluate all of the proposals. We finished in less than that.

Scrogham: Because of the abbreviated proposal format, or because two of those proposals were clear favorites?

Rider: The contractors could only submit 50 pages of technical data. They had to be very creative in their writing and proposing with respect to performance and handling qualities. There were no weapons or weapons delivery systems in those proposals because they were more oriented towards building a high performance airplane with very good handling qualities and a very high resistance to departure from controlled flight. That's what we were evaluating. In addition to the 50 pages of technical data, each contractor submitted 10 pages justifying what they thought it would cost. We did not at source selection really have much to do with the costs. We looked at the technical end of it. The contractors also had to submit force models. They were given one day each to set their force models up in the NASA wind tunnel back on the East Coast. Then they turned them over to the Air Force. The Air Force evaluated their lift and drag and profiles. This is the area where Colonel John Boyd got involved. This was part of what he really wanted to see-the aerodynamics of those models. After that, the program really got kicked off at Wright-Patterson. I was already working it, so I stayed on. I wound up creating a test force and trying to find a building to work out of.

There was a lot of stuff that we had to do to get started.

Scrogham: Your team included contractor personnel, Air Force Flight Test Center (AFFTC) personnel, and Tactical Air Command (TAC) personnel. How difficult was it to integrate three different groups into a single joint test force?

Rider: The flight test program was going to be 300 hours. That was the criteria. The 300 hours would be spread equally between the contractor pilots, flight test center pilots, and the Tactical Air Command (TAC) pilots. There was no AFOTEC at that time. It came along shortly thereafter. We were going to divide things into thirds, and that created a lot of interesting challenges for trying to run a program where everything we did was basically experimental flight test. The Flight Test Center had their "brand" on that stuff. I think I kind of ticked a lot of people off, but it wasn't my fault. It was the nature of the program. I had to figure out ways in conjunction with flight-testing to get the TAC pilots involved. They didn't have a problem with the contractor test pilots, but I had a problem getting the TAC pilots involved early with things that they had never been trained to do. We actually did some [flight test] training with those TAC pilots, and that kind of upset some of the folks at the flight test center, but it was something that had to be done. So, we did include them, and we did fairly well at dividing up the flight test time between the three fundamental organizations.

Scrogham: Could you talk a little about the personnel and the personalities on your team?

Rider: Bob Ettinger replaced an individual who was very vociferous about his feelings concerning the "stick" in the YF-16. He was so outspoken that the contractor did not believe that he could be a fair judge and give the airplane a fair shake. I felt bad about this, but we were given an open forum. I had to let people speak their mind. In this particular case, I knew the guy was ticking a lot of people off, but I didn't realize that it was getting that bad. General James Stewart, a 3-star from Wright- Patterson AFB, came out and relieved that individual. He was replaced with Bob Ettinger. Bob was a great replacement. He was very qualified and a good troop.

Duke Johnston was Mr. TAC. This guy had flown everything from the F-100 to the F-4. He had flown in combat. He knew what the TAC goal was and did a great job. Mike Clarke was the flight test center's primary pilot on the YF-17. He was well trained and not afraid to speak his mind when we got together and started picking the airplanes apart as we would do. Joe Bill Dryden was the primary TAC pilot on the YF-17. He was also a very well qualified TAC pilot-as was Dean Stickell. Dean's background was a little different. He had flown F-100s, then got stuck training in the F-104. So, he had dealt with a wide range of performance spectrums. He did very well.

Phil Oestricher was well qualified as both a tactical pilot and a corporate test pilot. He had commanded an F-8 squadron in the Air Force Reserves, so he knew his way around. The other contractor pilot from General Dynamics was Neil Anderson. Neil got into the flight test business kind of late. He was with General Dynamics for a long time before going to test pilot school. He was a good addition.

Hank Chouteau had been around forever. He was a good pilot, and really wanted to make his company [Northrop] look good. He tried to prove that the YF-17 would go Mach 2. It really wouldn't, but he kept running the damn thing out of gas trying to do it. Hank and Joe Jordan, the other Northrop test pilot, were not as open with us. They would have private post-flight meetings down in Hawthorne. We weren't invited. General Dynamics, on the other hand, were right there with us. We were all living in the same building. They never had Phil or Neil hold back information for a private debriefing. That wasn't true for Hank and Joe. They were pretty vague in their reporting. They reported to us, but we were pretty sure that they were taking their real comments back down to Northrop and putting them on the table there. Part of that was because Northrop's test group at that time was part of the marketing group. That really didn't make much sense to us.

Scrogham: In his biography of Colonel Boyd, Robert Coram states that Boyd objected to the involvement of Edwards test pilots in the LWF program. Were you personally aware of any such objections?

Rider: No. There answer to your question is no. I had not been aware of that until you mentioned it. I wasn't aware of any objections. I did meet with John Boyd on occasion, and we had some serious discussions about energy management and Energy-Maneuverability Theory. At no point did he tell me that we shouldn't be involved in this program. If that was an issue for him, it was so below the surface that I never realized it.

Scrogham: The LWF program began as a technology demonstration. What were your focus areas in the early days of the program?

Rider: We had a finite period of time and a very finite amount of flying that we could try to achieve in that length of time. What we were supposed to come out with at the end was a general evaluation. It wasn't supposed to have been a full-blown flight test program. We didn't do that until we got the A and B model F-16s, and later on I directed flight test for them as well. We had to assess the combat potential of these airplanes against some basic criteria. The criteria had to do with the time of acceleration from basically .6 Mach to 1.2 Mach. You had to be able to show that you had excellent maneuverability by turn performance. You had to do 4 turns at .9 Mach and 3 turns at 1.2 Mach. In performing these series of maneuvers, the airplane was supposed to have the capability to go to optimum cruise altitude and return to a base 250 miles away. That sort of set the kind of range we got. It really was a measure of combat capability and persistence. Basically, the YF-16 had it [persistence] and the YF-17 didn't.

Scrogham: How difficult was it to develop a test plan for the LWF program? What sort of challenges did you and your team encounter?

Rider: Hah! A lot of trips to Northrop and General Dynamics! First of all, the big challenge was handed to the Flight Test Center. As the Flight Test Center's representative, I had responsibility for developing a test plan for both the YF-16 program and the YF-17 program. What we did ad nauseam was meet with the contractors.

We were told to develop a detailed test plan, flight by flight, for the entire 300 hours of the program. We said, "There ain't no way!" But we did it anyway. We got together and started going through what we had to do first. You have to do some calibrations on instrumentation. There's just a lot of very technical stuff that you've got to get behind you. We had to get that behind us fairly quickly. We basically locked ourselves in little cubicles with the contractors, the flight test center people, and the TAC people. We lined the walls of the room with butcher paper, started with flight #1, and made detailed flight test plans. We fully realized that we probably wouldn't fly the plans exactly as written, but those plans would get us to the end of the program having flown sufficient time against each task. In the end, we would have a good understanding of the capabilities of each airplane against those tasks.

We started with a plan, but there's no doubt that by flight #3 or so we were already deviating from it. Even so, we still had a plan that took us right to the end. Because Northrop came in so late, especially with their second airplane, we had to make major adjustments to the plan. Northrop didn't even start flight-testing until 6 months after the YF-16. Then we were asked to add to those critical questions by accelerating the test program as much as we could. What we did was just exactly that. We accelerated the YF-17 program to the point that you may still have some oily spots on the ramp out at Edwards AFB from where we were parking our KC-97s. I got support from KC-97 outfits in the Air National Guard from all over the country. Some as far as Otis AFB back in Massachusetts. Most of the support came from a Texas unit at Hensley Field near Dallas. They took on the chore of organizing KC-97 for

us to have for flight test support at Edwards. All I had to do was talk to Col Smith in Dallas to get somebody over here. Many days we had three of them on the ramp at one time. We used them to accelerate the YF-16 as well. As soon as we got a primary YF-17 ready, I would call the tanker guys and say, "Let's go!" They would take off and we would be right behind them. What we would do is plug in and refuel on our way toward Tehachapi. Then I would tell the tanker to head East down underneath the supersonic corridor and go out a little bit further and make our accelerations.

Most of the testing that we did was supersonic. We would pass the tanker, turn around, and meet him coming back the other way and refuel going east. Then we would drop off and send him back to the west. Some days I think I refueled as many as 12-15 times. After the YF-17 went supersonic, it needed gas really quick. The YF-16 had a little better endurance. Thanks to tanker support, we were able to fly on the same day, in the same air mass, all of the combat relevant tasks on both airplanes, with one going east and the other going west. We wouldn't have been able to complete the program had we not had that support from the Air National Guard. It just wouldn't have happened.

Scrogham: You mentioned earlier that your team was in the business of experimental flight test. What were your primary technical concerns with the LWF prototypes themselves?

Rider: During Dean Stickell's first flight in the YF-16 the engine rolled back to idle. He had a dead-stick landing. We were concerned about that. We never really had to make

a single-engine landing in the YF-17. We thought the most highly probable failure in that would be the loss of roll control on one side because they were single-channel fly-by-wire ailerons. That never happened.

Scrogham: As I recall you also had an engine issue in the YF-16 similar to what Dean Stickell experienced.

Rider: Yes I did. I was coming back across the lakebed at low altitude. I pulled up, pulled the throttle to idle, and the engine rolled back to idle. I landed on lakebed runway 1A about some 40 seconds later. We had five or six rollbacks during the course of the test program. When we finally figured out what was causing the problem we took the problem part out of the fuel control and mounted it on a piece of poster board. We sent it to the factory to analyze and figure out where the contamination was coming from. We pretty well knew what it was-just aluminum shavings that had been left in the channels that they had cut to make the fuel control. It was kind of a big deal, but not a very big deal.

Scrogham: It must have felt like a big deal at the time.

Rider: Well, you didn't really have time to think about it. I knew that the engine wasn't going to respond, so I was going away from all of the landing places out there. I flew it right across the top of the hangars there on Contractor's Row, so the only land-able place there was right back behind me. So, I turned around and landed there. I had enough speed to pull up and do that. It wasn't too bad.

Scrogham: At what point did you realize that the LWF

program would wind up being more than just a technology demonstration?

Rider: Well, I guess the first real clue was probably 3 or 4 months into the program when damn near the whole Dutch parliament showed up at Edwards. They were one of the countries who were interested in what we were doing. You need to realize that Tom Jones at Northrop was really out marketing his version of the YF-17, which they called the Cobra. He had been doing a lot of talking about how this was really going to be a program. They had stirred up a lot of interest in Europe. So all of the sudden the Europeans were ready to start making commitments. Realize that at this time the US Air Force didn't want any part of these two airplanes.
As far as the prototypes, there weren't any weapon systems on either airplane. We did have a gun, but we had to fight like hell to get one on each-one YF-16 and one YF-17. That's all that we had done, fire a gun, during the early part of the program. The Air Force really wasn't interested in the program, but Congress got interested after the Europeans started showing their interest. The unit flyaway cost for the production version aircraft proposed by each contractor was on the order of $20 million or less. There was a lot of interest in this highly capable but relatively inexpensive fighter that they could buy en masse and have an air defense system.

Scrogham: Mr. Corram states that the YF-16 was the unanimous choice of pilots who had flown both aircraft because of its ability to perform a buttonhook turn. What do you recall in terms of a pilot consensus at the end of the LWF competition?

Rider: I'm not sure that the YF-16 was the unanimous choice of the pilots. It was unanimously agreed that it had the tactical advantage of being able to accomplish all of the combat relevant tasks whereas the YF-17 could not. That was the essence of our briefing to the source selection committee. That's another interesting point. When we eventually went to source selection, I only had 5 minutes to describe the competition. By this time, it was a competition. That's why we were having a source selection between the YF-16 and YF-17. I had 5 minutes to brief them and Duke Johnston had 5 minutes. At that point, in time the YF-16 was the unanimous choice of the pilots with respect to mission type things. However, it wasn't the unanimous choice with respect to fly-ability.

With the YF-17, you could put your daughter in it and it would go fast. It was a piece of cake! You had to fly the YF-16 all the time. You had to fly it all the way to the ground because you were landing it at a speed that it would like to still fly. We fixed part of that when we changed the speed brake on it, but it would still fly at the speed you needed to touch down. It was a little bit more of a handful. It wasn't hard to fly, but some of the guys related that it wasn't one of the YF-16's high-points. There were plusses and minuses on both sides. We looked at the total package though-maneuverability, ability to do the combat relevant tasks, acceleration, deceleration, combat sustainability, and combat endurance.

Scrogham: Did the LWF program change the way the Air Force Flight Test Center conducted developmental flight test?

Rider: That's probably true because we were really the first unit to install a big inertial navigation system (INS) in an airplane. We used an INS out of a Boeing 747 to measure all of the angles and rates. We were able to get all of that data very quickly and to print it out. We didn't have to wait for weeks after a flight to get data from the flight. We could get it right away. That was a change for the Flight Test Center. We also used simulation going into the program. For example, we flew the NT-33 with side-stick control. We did practice flameout landings in the NT-33. We did simulation of YF-16 and YF-17 drag characteristics.

Scrogham: Looking back on the LWF program, do you see any lessons learned that might still apply today? Are there any "enduring truths" that you feel could benefit current or future test programs?

Rider: I think I was very, very fortunate as a director to have people from these three different organizations that got along. Now, we didn't always agree, but there was never any disrespect in our disagreements. We respected each group's requests-what they wanted and what they thought they needed to do. I think that was a big part of our success. The other part was that we were given a charter and then were pretty much left alone to go do it. We did not have extensive oversight by the program office. Of course they were interested in what we were doing, but we were doing what they told us to do. We kept them informed. We had to do safety reviews-the standard things that you need for safety and efficiency. We did all of that, but we did not have any real interference from the SPO. We never saw anyone from Systems Command. The same thing was pretty much true for TAC because TAC

didn't want anything to do with this program in the first place. Our TAC guys weren't getting any direction. The only direction they got was to determine what they needed to fight a war with. We didn't have any big disagreements on whose turn it was to fly. I can't say that we didn't have any of that, but we had very little of it.

We had a high level of respect for each other's positions. We were able to cooperate and get the job done. That's what I see is lacking now. There is a lot of money involved, so there is a lot of extra management over each program. When the program isn't going well the first thing that higher headquarters does is change management. That may or may not be a good idea. Frankly, I don't think it's a good idea. We didn't have that. We had one SPO director-Bill Thurman-throughout the entire LWF program. When they decided to have a full-scale development program Bill Thurman had already been reassigned to the Air War College at Maxwell AFB. Because the LWF program had run so smoothly the Air Force decided that it was a bad idea to change leadership. So Bill Thurman moved back to Dayton.

By staying on as flight test director of the F-16 Test Force, I knew that it would probably be a career-ending or promotion-ending decision because I was also on the list to go to the Air War College. The only person that didn't stay out of that first critical team was Duke Johnston. TAC would not allow him to avoid Air War College and sent him there. Then they sent him to Korea to fly F-16s as a wing commander. Then they brought him back and fired him. That was not a happy deal. I think continuity was a big part of it. We had a lot of continuity in the flight

test pilots-both the contractor and the flight test center. I was able to keep some of the pilots that TAC had sent, like Dean Stickell and Joe Bill Dryden. They stuck around for a little while. They eventually pulled Joe Bill to Eielson AFB to fly F-4s. We had problems at that end of it, but it wasn't enough to scuttle us. We had good continuity overall.

Scrogham: We definitely appreciate your input and perspectives on all of this.

Rider: Well, I appreciate being asked. I really do think it turned out to be a good program. We had good management. Even when we went into full-scale development for the F-16, I had some great bosses out there. We changed bosses at the SPO a couple of times after we got into the full-scale development program. Jim Abramson at the SPO was a great guy to work for. I had an open line to him anytime I had an issue. I could call him and he would answer the phone. It was the same thing with Tom Stafford at Edwards. If he needed to know something, I would tell him. I didn't get any grief from him or from Jim Wood, who was the director of flight test. The only suggestion that I got from Jim Wood was during the inadvertent first flight of the YF-16. I was the test director and up in the tower. I had just witnessed this event. Phil (Oestricher) did exactly what we had briefed as an option should a problem come up. Jim called up and said that maybe we should make a couple of long approaches to see how it flies. I said that Phil ought to do what he thinks is right. If it looks good, he ought to land. And that was the end of it. Having good bosses that give you a job and let you do it was really an advantage.

Scrogham: So no micromanagement at all?

Rider: Well, I guess that I would say that some of the safety reviews by some of the people running them were kind of a pain in the ass. It was just because they didn't understand some of the capabilities. They were headed into areas that were really not production. But you know, that's what safety reviews do.

APPENDIX B
Gathering of Eagles Panel Discussion

On the evening of October 12, 2013, the Flight Test Historical Foundation hosted a "Gathering of Eagles" panel discussion at Antelope Valley College in Lancaster, California to commemorate the 40th anniversary of the Lightweight Fighter Program. The event was emceed by journalist David Hartman.

PARTICIPANTS

Michael J. Clarke,
Lieutenant Colonel, USAF

James H. Doolittle III,
(Ret)Colonel, USAF (Ret)

Robert C. Ettinger,
Colonel, USAF (Ret)

Mr. John W. Hicks

Mr. Richard R. Hildebrand

Mr. Frank N. Lucero

Mr. Phillip F. Oestricher

Mr. James A. Papa

James G. Rider,
Colonel, USAF (Ret)

R. Dean Stickell,
Colonel, USAF (Ret)

Mr. Charles Van Norman

Mr. Richard A. Wood

David Hartman: Jim, start us off. We saw the video. How unique was this program?

James G. "Jim" Rider: Do you want me to stand up or sit down?

David Hartman: You can sit down if you want. Or stand up.

Jim Rider: I'm not sure that the answer to this question is that simple. It was more than unique, this program. We had to assemble a group of people-probably all of them "Type A" personalities-and get them to test, discuss, and decide on good and bad features of two damn good airplanes. So, initially we were not a competition. Nobody believes that. I know it, but that's okay. It was not supposed to be a competition. However, when they decreed that the [Air Force] Flight Test Center would write the flight test plan point-by-point for both airplanes we were pretty well assured that it was a competition. My job was to kind of be sure that we ran that and gave both contractors a totally fair chance to do and show what they could do and show.

I think the program, even after 40 years, has proven that we pretty much did that. I had one team that really looked at the YF-16, and another team that looked at the YF-17. In the middle were two of us, myself and Duke Johnston. Duke and I flew both airplanes pretty much the same amount of time. We evaluated-we flew the same test points-that kind of thing. We spread our supervision, our flying, and our looking at the airplanes around. I think we did it pretty well equally. The idea was to come up with the documentation and what-have-you that we needed. It

was a lot more than just going down and flying the test. I had two great teams, but parts of those teams aren't up here tonight.

We had some enlisted personnel that quite frankly we tried to find but couldn't. At least I couldn't. I had three sergeants that were responsible for airplane general, avionics, and engine [maintenance] in the very early part of the prototype program. They evaluated both airplanes. They did everything from helping to decide what kind of fasteners should be holding all of the panels on, all the way down the line to the avionics. They were an integral part of the team. There weren't just flight test engineers and test pilots. The enlisted group we had working with us were absolutely superior. The thing is there were only three of them! They split their time between looking at both airplanes.

I think that the way the program went just evolved. We had all of these "Type A" personalities, and we spent a lot of time agreeing and disagreeing on things. We had a lot of late evening and late night meetings after a day of testing where we discussed the pros and cons of what we looked at that day. There were a whole lot of things on the program, but the fact is that we were allowed to really run the program. There wasn't somebody at the Pentagon or at ASD at Wright-Patterson [AFB] telling us what we should do every day. In fact, they didn't tell us what to do most any day. We had a test plan. When we wrote the test plan, we said, "We can't do this." They wanted us to write a test plan that had every flight, 300 flights for both airplanes. Point-by-point, all of these energy management points and everything else. We did that. We didn't fly it, but we

did it. After you fly the first flight you miss a few points, or you get a few extra points, and you have to adjust. We were adjusting constantly, but we flew the plan pretty much as we had developed it with each contractor way before we ever flew the airplanes. I think that gave us the plan to do the job, and to have the management structure and leadership structure to get it done. And I think we did. Thank you.

David Hartman: Bob, when you first got in the F-16, what surprised you? What did you find there that you didn't expect to find-that you hadn't seen before?

Robert C. "Bob" Ettinger: Well, with the original YF-16 flight manual we had contractor-written documents. We didn't have to rely on the MILSPECS for how to describe this thing [MICROPHONE FADES]. As you can imagine, the opportunity to fly two brand new high-technology airplanes with things slope back seats, forebody strakes, fly-by-wire, and a dozen other high-technology, brand new things was a fighter pilot's dream. It was truly a rare opportunity to participate in this program. As you can imagine, as the thing evolved, everybody got better and better. They kind of changed the rules from an independent technology evaluation of two different technology concepts to a head-to-head fly-off that included European governments that wanted new fighters. It turned into a wonderful program. I managed to hold onto it for 7 years, both the YF-16 and F-16. It was truly great.

David Hartman: Phil Oestricher, besides that high-speed taxi test, what surprised you? What did you find new as the General Dynamics chief test pilot when you got into the F-16?

Phillip F. "Phil" Oestricher: Well, the level of performance was so great it took a little work just to get used to it. I had been flying the latest model of the Vought F-8 Crusader up to that time in the reserves. This thing was light years ahead in terms of acceleration-not necessarily top speed, but maneuverability. Yeah, we had some problems, but they were easy to work over and around. I'd like to make a few comments following up on what Jim Rider said. All my life-from the time I was four years old according to my parents-I was interested in airplanes. I told them that at about five or six that I wanted to design airplanes, build them, test them, and fly them. It was a great boyhood dream. Well, I got to do it. And I got to do it on a program that, as far as I'm concerned, was the Camelot of aeronautical engineering. We were given this task of designing, building, and testing a pure air-to-air fighter airplane. Now please, avionics guys excuse this, but it's not complicated with all kinds of look through the floorboard sensors and all of this. It was a pure airframe with a great big engine in it with very innovative controls. We were exploring this "does an unstable airframe give you more maneuverability" concept. As Bob said, all kinds of new things, but its pure airframe was what I loved-aerodynamics, propulsion, and structures. To me it was just an absolutely fantastic experience. I don't know how else to describe it. I was very fortunate, and I think the others on the program felt the same way. We were exploring new stuff, and just trying to find out if it's really any good or not.

David Hartman: By any chance, were you referring to the F-35?

Phil Oestricher: Not necessarily. I think everything today is loaded with those gadgets that just sort of get in the way of flying airplanes.

David Hartman: Mike Clarke, you're the first YF-17 guy besides Jim [Rider], so you've got a chance to get on the F-17 here. How was that airplane?

Michael J. "Mike" Clarke: It was a tremendous airplane. Like Phil, from the time I was nine years old I wanted to be a pilot. By the time I was twelve, I decided I had my career path planned out. I wanted to be a fighter pilot in the Air Force. I wanted to be an [Air Force] Academy graduate and become a test pilot. My dream was flying a YF-17. It was a beautiful airplane. [MICROPHONE FADE] It was an airplane that you could fly without worrying about going out of boundaries on it. They achieved their goal. You could fly that airplane truly with abandon. If I get a chance to talk again later, I'll describe one maneuver that I experienced that was unbelievable. It was Duke Johnston, who could not make it here tonight.

I would also at this time like to acknowledge the other key pilots in the program: Hank Chouteau, who was the chief test pilot for Northrop-Phil's counterpart; then my counterpart, Northrop test pilot Joe Jordan, who died a number of years ago from a heart attack; and Joe Bill Dryden, the TAC pilot who worked with me during the AFOTEC evaluation of the airplane, and also passed away in an F-16 accident. Tremendous contributions by those people as well. One thing that I'd like to point out that hasn't been mentioned so far is that when the Air Force did the RFP (Request for Proposal), they didn't lay on a lot

of requirements except a combat mission and the task of evaluating the airplanes against the contractor-proposed performances. That's primarily what we did. The contractors were also tasked with as many innovations as they could possibly do. Now, the fighter pilot mentality normally is that if you give him a new airplane but you only give him one ROC (required operational capability) it's an improvement. If you give him two ROCs, he's going to get worried about it. Three ROCs? No, you give him one ROC at a time with advanced technology. These contractors each came up with 6 to 7 innovations that probably would never have happened had the Air Force not taken a hands-off approach and let the contractors design the airplanes the way they thought best to achieve the one defined combat mission.

We evaluated everything against their forecast parameters at that point. One of the major differences between the airplanes, both of them tried to achieve a flight envelope where the pilot wouldn't go out of control, either in the alpha, or over "g." General Dynamics used their computers, "g" limiter, and alpha limiter. Northrop took the approach of sizing the control surfaces and wing load limiting. Both of them did a remarkable job of achieving an airplane that you could fly without worrying about it.

David Hartman: If you'll look at the cover of the program, there's a photograph of the two airplanes. Do you all know who was flying those two airplanes in that photograph?

Michael Clarke: Mr. Ettinger here was flying the YF-16, and I was flying the YF-17. It's an interesting story in itself. We were never, ever allowed to be anywhere near the YF-16s in flight. Very seldom did we ever taxi past them. We also weren't supposed to fly the YF-16 and YF-17 in the

same airspace. But, if a congressional committee came out, or a big-wig group from the Pentagon came out, they could request to waive the rules and get the two planes together in flight for a photo op. That happened once, and that's the only official picture ever taken of the two airplanes in flight together. It's a beautiful picture. I had that turned into an oil painting that's hanging on my wall.

David Hartman: Jim, you're nodding your head here. What are you nodding about?

Jim Rider: He's dead-on. We did that one time. It was strictly a photo op. We didn't do anything grandiose. We weren't trying to show that one was better than the other one. It was just taking the two airplanes up there and flying them in formation. We flew with the YF-16 in the lead part of the time and the YF-17 in the lead part of the time. The picture you've got is one rather than the other. It was purely a photo op.

David Hartman: Dean from TAC, how did this airplane stack-up in your mind as a potential fighter aircraft/ combat airplane?

R. Dean Stickell: I don't think the original question you asked was answered. If you don't mind, I'd like to answer that question. The question was asked about surprises. I was one of the operational guys on the test program. When I got to Edwards, I was totally unfamiliar with test procedures and flight test. I talked with these guys, and the one impression they left me was that in today's environment-that was the 1970s-there were very few surprises in a test program. So, I thought, "That sounds kind of easy."

Before the first flight was flown-a couple of days prior to it-Phil [Oestricher] had his high-speed taxi test turn into a first flight. I thought, "Hey, that's kind of a surprise!" Bob Ettinger, on his first flight, cranked-up and his engine wouldn't come out of idle. I went home that evening thinking, "Man, that was kind of a surprise." On my first flight, I climbed into the airplane, took off, climbed up to 15,000 feet, and pulled the throttle to idle. When I pushed back up the middle, nothing happened. It stayed in idle. You can bet I was surprised. I went home that evening thinking, "Flight test is full of surprises! It's really exciting!" Then three or four weeks later Jim Rider was flying a mission. For those of you who aren't fully aware of flight test, you generally fly a chase airplane with the test airplane. I was flying chase. Jim said he was doing a low approach. He briefed that we would do a low pass over the hangar. That was very commendable of Jim. Not only was he a great test pilot, but he was also looking out after his leadership capabilities in terms of his flying hours as the Joint Test Force director. We came over the hangar, pulled up, pulled the power back, and slowed to 300 knots. Guess what happened next. The engine stayed in idle. Don't let him tell you that he wasn't surprised. I wasn't surprised, but I'll guarantee you that Jim Rider was surprised. We encountered a lot of surprises, so thanks for asking that question.

David Hartman: As an engineer, how new was all of this to you to do the work on these airplanes?

Richard R. "Dick" Hildebrand (RH): How new was it?

David Hartman: They've talked about a number of new additions…

Dick Hildebrand: Actually, from an engineering standpoint there wasn't a lot that was "new" except for a lot of new technologies. The newest thing was that everything worked on both airplanes. I would like to touch on being an engineer. I don't have exciting stories to tell because they didn't build them with two seats.

There were three or four of us engineers and the pilots who were cleared on both test programs, but other than that, the two test teams were entirely separate. Separate from the standpoint that you were either an YF-16 guy or an YF-17 guy. In working with the contractors to design and plan the test program there was total cooperation. I don't recall any issues with either of the contractors. We had a very simple set of requirements, and the idea was to let the contractors show what they could do. The requirements didn't change. Probably most blessed of all, we didn't get a lot of interference from above. The test community was allowed to figure out what these things would do and show it.

The technology of both aircraft was achievable compared with the occasional "pie in the sky" stuff seen in some of these programs that are now in their twentieth year of development. Everybody from both contractor teams and the Air Force team were focused on a simple set of objectives. And you know, darn it, we did it!

We had a lot of experienced people, and a lot of dedicated people from both the contractor and the Air Force side. If

you look back on it, in one year of flying the YF-16 and six months with the YF-17, we pretty much accomplished all of the objectives that were set out. I look back forty years later, and a heck of a lot of programs later, and not many people can say that. I think it was a good example.

David Hartman: Chuck Van Norman, I've asked the others about actions and reflections on what these programs were. What are your deep personal reflections on your experience with the YF-16?

Charles "Chuck" Van Norman: Let me comment first of all that I felt we had two roles. The first was to facilitate the development of both airplanes so that the contractors were capable of doing that. The second was to do an independent evaluation of both airplanes. The development part of it was an exceedingly great experience I think because of the cooperation between the Air Force and the contractors.

From an engineering standpoint the question was asked, "Did you see anything new?" I think we saw breakthroughs. We were dealing with airplanes that performed at a level that had never been seen before. We used engineering techniques and facilities that had not been used extensively before. We used stability derivative extractions. We used Handling Qualities During Tracking (HQDT) to develop the flight control systems. I was the lead for performance and flying qualities. The performance engineer who worked with me, John Hicks, is here and can talk about performance issues. There were some new things in the performance area. The flying qualities engineer was Jim Eggers, who is not here tonight. It was just a tremendous experience-the first fly-by-wire airplane.

We used a lot of simulation in order to develop the flight control system. Since we had the analog system based in the simulator, we could do a flight, find deficiencies, receive corrections from General Dynamics engineers, have the technicians make changes to the flight control computer, conduct a safety review, and fly the changes-sometimes the very next day. That was kind of unheard of. I think there was a lot there.

I want to make one other comment. Dean Stickell talked a while ago. Dean Stickell was not a graduate of the Air Force Test Pilot School, but he was a very conscientious guy-eager to learn. He brought back some of the best flight test data during the program.

David Hartman: Jim Papa, same question. Any reflections as you look back over the program and your experience with it?

James A. "Jim" Papa: Sure Dave, but first I would like to preference my remarks with the fact that when Bob [Ettinger] asked if I would like to participate on the panel my first thought was "I can't remember what happened forty years ago! I'm not going to be very useful!" After a little bit of thought I got some boxes out, looked through some old files, and started piecing things together. It was a time in our life where, in the previous year, Regina and I had just gotten married. During the program, we had our first son born. I remember just having the best job that a person could have-being a flight test engineer. The excitement of this program, and the kinds of things we were doing, was very fulfilling.

Hildey [Richard Hildebrand] mentioned that we spent a lot of time with the contractors planning this program and that they were very cooperative. In fact, we not only cooperated on the test program itself, we worked with the contractors to try and come up with common approaches to the flight test techniques and analysis so there would be some sense of commonality when we came to evaluate the airplanes. Even though we weren't sharing things about each contractor's airplane, we were talking a lot about how we were going to put the analysis together so that you wouldn't come up with things that were apples and oranges.

As far as the actual execution of the program, I remember spending a lot of time focusing on whether or not we were getting the right priority test points done. One key way that the program was put together was that it was a series of tests that would specifically be the minimum needed to answer the questions. As Charlie pointed out, there were some early, simple specifications that we had to answer. So, it was important that we were making progress on those types of test points. I remember that I had a chart in a cubicle in the hangar plotting test point progress and whether we were meeting them, and whether the quality was filling out the top row. As many of you know, flight test in itself-and a great deal of the activity of a flight test engineer in particular-is bookkeeping. Keeping track of what you're going to do. Keeping track of what you did and how you did it. That in and of itself is not a simple, straightforward task. In this program, things seemed to move so smoothly that when we had problems we attacked those problems and solved them very readily because we had some of the best cooperation between the

contractors and the Air Force people and we were using a lot of simulation techniques. These things allowed us to come up with the answers.

One of the technologies that was not associated with the airplane, but was associated with flight test techniques, was the inertial reference system-the inertial guidance system of the YF-16. It was used to obtain performance data in a way that we had not done before. I spent a lot of the time with one of the General Dynamics contractors who developed the mathematics that became part of the data analysis. With what he did, I took and began to implement into our Air Force Flight Test Center test system. That in itself was similar to a PhD thesis with the amount of vector translations. That was one of the things that I remember as far as my personal experience.
Unfortunately, I had to leave the program when the Air Force said, "You need to go to graduate school." So, I left about two or three months before the fly-off was over. In the meantime, Charlie had come back from school and overlapped with me while working on the YF-16 program. Once again, as everyone has mentioned, it was a rewarding experience, and one that I'll never forget.

David Hartman: Jimmy D., talk about your airplane, or one of these guys if you want.

James H. "Jimmy" Doolittle III: First, I want to talk about Mike Clarke for a minute. I'm surprised that it took Mike all the way to twelve years old to decide that he wanted to be a test pilot. Mike's a little bit of a slow starter. I think I knew that I wanted to be a test pilot when I was about four years old. Take that!

David Hartman: You know, you have a little tradition in your family as I recall.

Jimmy Doolittle: There was always this little kid tripping over the cracks in the sidewalk because he was craning his neck up looking at B-17s. It was 39 years ago. I was digging through the same boxes that JP [Jim Papa] was digging through. I don't have a memory. I can't remember what I had for breakfast. I wrote my notes down. I'm going to go through this really quick.

Right after Southeast Asia, the Air Force had a glut of pilots. They took a bunch of good, solid, young military engineers and-this is a very sad thing-kicked them out of the service. They didn't have enough flying jobs, so they took the pilots with engineering degrees and stuck them into the engineering jobs. I got an assignment dropped on me to go be a "roads and loads" guy at Shepherd AFB. I made a world record trip up to AFMPC from Laredo where I was in a T-38 squadron, and begged and pleaded to go over to a rated job here at Edwards.

I worked on the F-15 test force for a while. I worked on the A-10 for about a year and a half, where we shot some holes in a hangar wall. I made the notes so I wouldn't get off-track, and I've already gotten myself off-track! It was a great time to be at Edwards. You know, there were seven fighter/attack test programs ongoing at the same time. There were also two different bombers, two cargo prototypes-the YC-14 and YC-15, and a little flatiron shaped X-24B that Mike Love-rest his soul-was flying that proved the concepts for the space shuttle. So, you had the AV-8B, A-10, B-1A, B-52, YC-14, YC-15, YF-16, YF-17, F-5E,

F-5F, F-15A, and X-24B. The Test Pilot School was still flying F-104s.

Here I was assigned to Edwards Air Force Base as a young captain and test pilot wannabe. I was an applicant. I got to be an alternate two or three times, and PCSd out to go fly the A-7 without being a test pilot. I was assigned/attached down to Test Ops flying the T-38 as a chase and photo guy. I remember good-natured Frank Lucero here. Every time the phone would ring, I would pick it up and say, "I'll be right there." Frank would good-naturedly give me the stink eye because I was going out. I was supposed to be an engineer, but I was going down to the Test Pilot School…

Frank Lucero: It was a challenge folks!

Jimmy Doolittle: As the YF-17 systems project engineer I oversaw a team of eight specialist flight test engineers. This was matrix management. These were a bunch of guys-a wonderful herd of cats-that came down and did their job, but I wasn't their rating official. If you ever had a leadership challenge, it took matrix management to get the job done. You had to get guys to do what they wouldn't otherwise do just by working with them. We published a couple of test reports, and Frank will attest to this. Frank was my mentor, and we put test reports together.

The YF-17 flew 288 sorties for 342 hours. It first flew on 9 June in 1974-two months after the announcement was made that this isn't a technology demonstration, this is a source selection, winner-take-all competition. We're going to produce Air Force airplanes, and the winner gets picked. You should have seen our faces the morning that

our bosses walked in and said "Hey guys. We've got some new direction. This isn't a technology demonstration. This is a fly-off." The sense of urgency got really, really big.

There was a tremendous sense of cooperation. The test team had a wonderful mix of engineers on the Northrop side and our YF-17 side of Air Force engineers. Jim [Rider] did a good job of reminding us how valuable those NCO maintainers were. If you can't keep the airplanes available, get the airplanes in the air, put the weapons on the bad guys, and get back up in the air to do it again, you're not going to win the war. The YF-17 boasted maintainability and access. Some of the folks here will remember the F-4. With the Phantom you had to take out the back seat canopy off the airplane, you had to remove the rear ejection seat, just to get to its battery. You couldn't just go down to COSTCO, get a battery, and put it up in the wheel well. It took an entire day to put a battery in a Phantom! What kind of questions did systems engineers ask? We weren't worried about performance and flying qualities. We were worried about whether or not the engineering was complete. Do all of the different hydraulic, electrical, and fuel subsystems all play well together? Can we keep it in the air? We thought about maintainability, ease of maintenance, ease of access, things like that. All of these systems are like a sports team. They've got to play well together. Has anyone bought a new car in the last couple of years where stuff didn't work well together? Did you end up spending a lot of time in the dealership? Show me your hands. We wanted to be able to say whether or not it works fine and lasts a long time. The conclusion was that the YF-17 demonstrated overall mission reliability of 89%. Considering that this was a brand new airplane 89% was pretty good.

In closing, let me talk about leverage. The Air Force went out and offered Northrop and General Dynamics each in the neighborhood of $38 million each to build two prototype airplanes. They had completely free reign to build at spec speeds a safe, capable, and extremely maneuverable machine. They were told to build an airplane for air superiority; build an airplane that's good for air-to-ground; and don't worry about what we've done before. Build an airplane that's maintainable. Build an airplane that doesn't require great big stands to change out a radio. Tremendous leverage. Tremendous successes. If you count the grand total of all of the Hornets-my Wikipedia number was 2,107 Hornets-and going on 5000 F-16s, figuring that they spent $38 million dollars apiece in 1972 dollars, that's 7,107 aircraft. With that, Frank, I thank you for your patience with me sneaking off to go fly all of the time. Thanks.

David Hartman: John, have you got enough to work with here? We've heard a lot about both programs. Where do you come down on all of this?

John W. Hicks: I recently had an opportunity to look back on 33 years of civil service and reflect on what I really enjoyed. My years at the Air Force Flight Test Center were hands-down the best. Of those years at the Flight Test Center, I think the highlight for me was the YF-16 program. I was relatively young compared to most of these old guys up here. I vaguely remember in 1969 being in a lush, green, beautiful place in Texas called Austin. I drove west and it got browner, and drier, and hotter. I'll never forget it. It was like a scene from "The Right Stuff." I turned at the North Gate at North Edwards and started

in thinking "I have made the worst mistake of my life!" It got worse the further onto the base I drove. It was hot. I was seeing mirages.

Out of the ten job offers I had, this was the lowest of the ten. I took it thinking that it was my chance to work with airplanes. The highlight for me was the YF-16. I was a performance engineer. I had done the same thing with the F-111. They were very traditional-traditional flight test techniques, traditional flight test processes. Then I got to the YF-16 and everything was compacted and compressed on each system. I never really appreciated it until Ettinger called me up and said, "Remember that?" I got to thinking about it, and I thought wow, that really was! We combined flight envelope expansion and flight test evaluation into one nine-month program on the YF-16. We also went on to do an ops eval, and an air combat maneuvering program out at Nellis on top of all that. We did all of that in twelve months, and I've never before or since then experienced a program that was so compact.

I remember that I worked the longest hours on the hardest job-ten to twelve hours a day, six days a week-until I was absolutely exhausted. All for the lowest pay that I ever took home in my life. Despite all of that, I had the most fun with the best people I've ever worked with. I mean that sincerely. They were the very best people that I've ever worked with. I'll remember it forever. When it was all said and done, I had the most fun and the best job satisfaction. That's what I valued irrespective of the pay.

We worked totally seamless as a government/contractor team. There was no contractor/blue-suiter divide. It was

all one seamless team. We worked together as if we had always worked together. We did some things, as Charlie Van Norman alluded to, like going into the INS. We had always used flight path accelerometers. We had to do the full Colonel Boyd piece of that, specifically excess power charts. The only way that we could do that was to tap into the INS, which had never been done before, to get flight path accelerometer and flight attitude outputs. We used dynamic flight test techniques, which up to that point had only been sort of experimental-we were playing around with them. Here we had to get really serious. I remember the hours that Bob Ettinger would go out and practice faithfully. He would do those damn roller coasters they wanted him to do. He would go out and practice and practice until he got them down.

Nothing was "typical." Everything was atypical-the team, the mission, the technologies that we had to deal with. It had never been seen before. Everything that we did was barrier breaking. When it was all said and done-when the smoke cleared-we were just absolutely burnt to a cinder from the long hours. Looking back on it now, I think, "Damn, it was one of the best jobs I've ever had."

David Hartman: He used the word fun. Did you have any fun doing this?

Frank Lucero: We did have fun on this program. [MICROPHONE FADES.] As I look back though, we weren't doing it for us. We weren't doing it for the SPO (systems program office). We weren't doing this for the contractors. We were doing it for our warriors who came later. Sure enough, it all turned out that way with the F-16

and F-18 both. I personally spent 44 years at Edwards and worked on many a program. As I look back on this, there were two programs that were most satisfying to me: the Lightweight Fighter program and the F-16 production program. The latter involved the same people. We went on to the F-16 production program and worked for Jim Rider. I felt as though that program was successful also based largely on what we had done during the Lightweight Fighter program.

David Hartman: Have we left you any ground to cover?

Richard A. Wood: Not very much! As to the fun, we must have been having something because I spent 33 years at the Air Force Flight Test Center before I retired. It was the only full-time job I've ever had. So, we must have been having fun or something else. John Hicks pointed out that federal government jobs are not the highest paying, but I didn't pass it up for anything else. I had a wonderful career. As for an earlier question about whether we surprised by anything, as engineers we spent a lot of time studying the airplanes prior to them even showing up for their first flights. We had a pretty good understanding of what the technologies were, so I don't think there were any surprises. I think in the end the biggest surprise was that we completed the program on this very tight schedule and got the answers to the questions. When I think about it in hindsight, all the programs that I worked on afterward got longer and longer rather than shorter and more concise.

Like everyone else it was forty years ago for me and I didn't remember very much. I had to go back into the

base and read the copy of the report that I had written to remember what I had said about the airplane and what the pilots had said about it. I was amazed at how short and concise it was. We got the answers and we got the program done. In hindsight, it was the smallest report that I was ever involved in. Now I'm asking myself why, as the years went by, these flight test reports got bigger and bigger. I think the real success was that the program was completed in a relatively short amount of time. That's the answer to the question. The rest as they say is history.

David Hartman: Let's go back to Phil Oestricher. Phil, you took a photograph of Mike Clarke one day. What was the subject of that photograph?

Phil Oestricher: Mike was flying the YF-16. I was riding in the back seat of a T-38 with a camera, which is a pretty dangerous situation. I had loaned Mike a World War II style leather helmet with goggles and all that. We had planned ahead of time that Mike would take his helmet off and put on the leather smiling jack style helmet. We got a great picture of Mike flying the YF-16 like that. I'm going to let Mike describe what happened next, what he went through after "officialdom" saw that picture.

Mike Clarke: This all came about because of my first flight in the YF-16. During takeoff, I made the statement that I needed to come back because I had forgotten something. They asked me what I was talking about, and I said that I had forgotten my leather helmet because it was like flying in an open cockpit airplane. So, in preparation for my second flight Phil climbs up the ladder and hands me a leather helmet. I had it modified with earphones and a boom mic.

Somewhere around my fourth or fifth flight we were at 33,000 feet doing flutter testing in the afternoon. We had to wait about 5 minutes between test points before the engineers could go any further. During one of those 5-minute periods, I took off my helmet, put on the leather helmet, and Phil took pictures of it. The flight deck was below and it was a pretty picture. It was very sharp, but also very apparent that I've got my regular helmet on my knee.

Now later on when we did the full-scale proposal the Air Force said, "We want a front quarter shot of the F-16 in the air. Now they claim they didn't realize that they put the picture in the full-scale proposal, but the interesting thing is that no one caught it. It went through review at General Dynamics, at Edwards, at Wright-Patterson, and got all the way back to the East Coast. Of course, all the guys over there had to do was look at pictures. They're all looking at the pictures of the proposal and they see this one. They start asking what this white thing was sitting near the canopy. Someone says, "That looks like a helmet!" Then someone else asks, "If that's a helmet, what's he got on his head?" Out came the magnifying glasses.

Do you know what happens when you take a snowball and roll it from the top of a mountain all the way downhill? It gets pretty big by the time it gets to the bottom. When it finally got down to Jim Rider's office, it would barely fit through the door. He called me in, and it wouldn't fit when I was going out. From there I got to go see the wing commander. He laid it on me a little bit. As I was about to go out the door he calls me back and said "Mike, you will not do that in the YF-17. You will not repeat it in the other airplane."

Phil Oestricher: I'd like to leave you with a little story here. I started work at what was then Consolidated Vultee as an aerodynamics engineer on the B-36. I did some aero work on the B-58 after I finished my Marine Corps stint. I also did some aero work and exterior configuration on the RB-57F. I had one foot in the engineering world when I managed to talk them into transferring me to the flight department. They sent me to Patuxent River. When I came back, I was flying F-111s. I'm sitting there between engineering and piloting when along comes the Lightweight Fighter prototype program and my high-speed taxi adventure.

That evening the chief engineer, the program manager, and the chief of aerodynamics on the YF-16 program were staying right here at the Antelope Valley Inn. They summoned me for a little conference. I didn't know if I was going to get a medal or get fired. Getting fired seemed the most likely outcome. I went to the room where the program manager was staying. I knocked on the door. When I was admitted, I saw that all three of those guys were half in the bag muttering things like "Boy, didn't that thing look great in the air? It was fantastic!" So, I decided to just go with the flow. It seemed like the logical thing to do at the time. I apologized for bending the tail up, but they said it was no problem. They had already called back to Fort Worth to get the tail from YF-16 #2. They would fix this one and place it on #2 later. That was one little insight into management and pilots. There's quite a bit of difference in there at times.

Let me give you one other little story and I'll quit. I had done my own personal analysis of the likelihood of the YF-16,

balanced as it was, being a successful flying machine. I thought that it was okay. The horizontal tail seemed a little bit small, but I thought that it would probably work fine. It turns out that engineering wasn't so sure. They had bulkheads spaced exactly the same amount of distance apart and wing spars such that if needed they could move the wing back a notch. All you had to do was manufacture some fittings and probably have a stable airplane that would fly.

The reason they were so happy was that they found out that yes, it was flyable! It really did work! To me that was an interesting insight. Even with all of the wind tunnel work there's still a certain level of uncertainty, at least in management, about whether they really do have a workable machine. As you know, it all turned out great. It was a wonderful program. I had a lot of good enjoyment of it and good feelings about doing it.

Mike Clarke: I have a management tale to tell as well Phil. I went out to fly the YF-17 one day and I found 2x4s in the cockpit. Two 2x4s in the right rudder channel. Two 2x4s in the left rudder channel. We had between us quite a discussion about which airplane gave you better "g" tolerance: the YF-16 with the 30-degree tilt-back seat or the YF-17 with only 17 degrees. The argument got so fierce that four of us were sent down to Brooks to go through the centrifuge for a special study to see what we could find out. It was inconclusive. What did come out of it was that the elevated heel line of the YF-16 was thought to make a contribution that neither of the seat back angles we were flying with did.

Northrop didn't want to be outdone on this, so one night they cobbled together these 2x4s-two on either side-and I was asked to go up and do a quality assessment to determine whether or not I got better "g" tolerance out of it. I didn't like it. I objected, but I was pressured into doing it. I tried to taxi the airplane, but the 2x4s raised my heel up to the pivot point of the inverter pedal so that instead of having the pitch-lever rotation point across the ball of the foot now it was on my heel. So, every time I tried to steer I got brake. I was all over the place trying to keep a straight line going out.

I came back and AFPO got involved. The Air Force got involved. The contractor got involved. They pushed that I should really go ahead and do this. I went ahead and did it with some guarantees that I wouldn't blow up my tire on the way out. We measured the temperature when I got to the runway. Most of you know that at Edwards it takes about 1.2 miles to get out to the runway. The tires were okay so I took off and left the gears down for a while to cool off. I flew the mission.

Qualitatively I was being asked questions and I came back saying that I got a better quarter "g" here and a half "g" there. When I came in to land, my shins were already sore from trying to taxi out and keep my toes back. I was on my final approach, my legs were aching, and my toes were back as far as they would go. When I touched down my right main tire blew. It rolled 21 feet and it exploded.

We found out that it was an old tire to begin with. It had more landings on it than the other tire. It cut loose. The magnesium rim disintegrated. Tiny pieces of metal

were flying everywhere. Pieces were flying out in front of the airplane and I stopped the right engine because we only had five engines. Four were flying at any one time. When I shut that down, I realized that I had just killed both hydraulic systems. When the wheel disintegrated, it backed off the b-nut and the hydraulic fluid from one system was bleeding out on the ground. I lost the other system when I shut off the engine. I had no noticeable steering and I was told that I was on fire. I got stopped on the runway though close to the center line. I climbed out the left side and dropped to the ground.

While I was watching all of this stuff going on around the airplane here came the safety officer. He was barreling across the field. You've got to understand that he was upset to begin with because this was at 5:00 pm on a Friday afternoon. He was on his way to the officer's club when he had to respond to this site. He cut across the infield and must have hit a ditch he didn't see because that car got airborne. He was a tall guy name Mac Jones, and he hit his head on the top of the car. He was pretty sore when he got out there and asked me "What kind of an emergency are you having?" I said, "I'm not having an emergency. The airplane is." " Okay" he said. "What kind of an emergency is the airplane having?" I said, "It's on fire!" I wasn't too happy about the way he approached me. I wasn't too happy that I let myself be talked into this. He asked, "What caused the fire?" I told him, "There's a bunch of lumber in the cockpit." He looked at me as though I was losing my marbles and wanted to get up there and see it for himself. When I told him that he couldn't do that, he asked me why not. I replied that the plane was still having an emergency. He got back into his car and took off. We

never pulled that kind of stunt again. It was a lesson learned-don't let yourself get talked into something that you're not keen on.

Jim Rider: This might sound kind of unusual, but we had at the task force level an attitude to try out different things within certain limits because these were initially research vehicles. It was pretty much left to me.

David Hartman: One thing as I'm standing here thinking, that they could develop two airplanes that became two of the greatest airplanes the world has ever seen, and we can't get two microphones to work properly! Here's to your Gathering of Eagles Honorees for 2013!

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