The Lightweight Fight of the Century:

YF-16 vs. YF-17

No one could predict there would be two winners in this epic battle for air supremacy

By Geoffrey P. Michael, ’73

In the early 1970s there was a protected area inside Northrop's aircraft plant at Hawthorne, California, that could only be accessed with a special blue security badge. Inside, a cadre of handpicked employees was designing and building the YF-17 Lightweight Fighter (LWF). Northrop's program was cloaked in secrecy because General Dynamics was then hard at work on its own version of the LWF.

The winner of what would later become known as the "arms deal of the century" stood to receive thousands of orders to produce advanced tactical fighters for the U.S. Air Force, Navy and nations worldwide. The original technology demonstration program would evolve into a head-to-head competition for the next Air Combat Fighter. In the end, thanks to a radically different approach to weapons procurement, both teams would build innovative fighters that have become the superstars of today's combat arsenals.

The LWF's evolution can be traced back to lessons learned in the Vietnam War, experience that was applied to a new generation of specialized weaponry. Among the workhorses in Vietnam, McDonnell's F-4 Phantom II served as an interceptor, fighter-bomber and reconnaissance plane.

Originally developed by the Navy, the F-4 overcame initial reluctance by the Air Force to become its principal air superiority fighter. While Phantom pilots achieved favorable kill ratios in that conflict, their combat experience revealed that American aircraft needed improvement to successfully challenge the latest generation of Soviet fighters. After careful analysis, the need for a more nimble fighter became obvious.

In January 1969, Grumman Corporation was awarded a contract to develop the Naval Fighter Experimental (VFX), which evolved into the F-14 Tomcat. Used for tactical reconnaissance and air defense, it was later retrofitted with an infrared targeting system for precision strike missions. While the VFX was intended to be light and nimble, neither objective was achieved. Design changes, performance upgrades and additional avionics combined to make it the biggest fighter of that era, and too expensive to replace all existing fighters. Another, cheaper option would be needed.

During the same timeframe the Air Force, looking for a long-range air superiority fighter, rejected the VFX, convinced it wouldn't meet performance requirements. The goal of having both services share a single fighter platform to reduce costs seemed noble in light of the F-4's success. However, that objective became more elusive as

The YF-16 during test flight phase.

technological advances and new mission profiles kept pushing the state of the art, and the Soviet Union developed fighters with specialized mission capabilities that surpassed their U.S. counterparts.

In December 1969, the Air Force chose McDonnell Douglas to develop its Fighter Experimental (FX), officially designated the F-15 Eagle. It would share the twin-tail design of the F-14, but not the variable-sweep wing. One aspect of the F-15 that would play a pivotal role in the future was the selection of Pratt & Whitney to supply its new F100 jet engines.

While the F-14 and F-15 were important additions to the U.S. fighter arsenal, both were still considered too large and heavy for traditional air-to-air combat. An informal group of advocates known as the "Fighter Mafia" supported the Energy-Maneuverability theory advanced by Colonel John Boyd, an exceptional fighter pilot and military strategist who had developed quantitative performance parameters to facilitate comparison of proposed aircraft designs.

Boyd served in the U.S. Army Air Forces during World War II, and later as a flight instructor known for his standing bet that he could beat any pilot in a mock dogfight in 40 seconds or less. "Forty Second Boyd" never lost that bet. While his disciples admired him, the brass deplored his confrontational methods and attempts to expose waste and corruption. Boyd

The YF-16 and the YF-17 in a rare side by side test flight.

The F-16 on active duty

acquired several nicknames, including "Genghis John" and the "Mad Major." Despite his abrasive personality, he became a central figure in the development of future fighter aircraft.

While Boyd favored small, nimble fighters, his tradeoff analyses helped to rescue the F-15 program when it foundered early in its development. The final product was still costlier and heavier than he had envisioned. At U.S. Air Force Headquarters, Boyd teamed with analyst Pierre Sprey and fighter pilot Colonel Everest Riccioni to lay the groundwork for a smaller, more maneuverable fighter. The result was the FXX, better known as the Lightweight Fighter.

Acceptance of the LWF was hastened by Congressional refusal to spend money on upgrading and purchasing more F-14s and F-15s. The idea of a cheaper aircraft that could be built in large quantities was appealing because of the economies of scale. Boyd's concept called for a gross weight of about 20,000 pounds, half that of the F-15. It would be designed to minimize drag, and be light enough and produce enough thrust to accelerate in a vertical climb. With a higher-lift wing to reduce wing loading, the aircraft would have increased maneuverability and payload capacity while sacrificing top speed.

Ironically, it was the unveiling of the Soviets' big MiG-25 in 1967 that helped push the idea of the smaller fighter into the limelight. With a ceiling of 90,000 feet and maximum speed in excess of Mach 2.8, the MiG-25 was fitted with powerful radar and four air-to-air missiles. Its massive engines provided quick acceleration and a climb rate superior to that of any American fighter.

To counter the new MiG, the F-15 was redesigned to accommodate bigger engines, advanced radar, increased fuel capacity and more weapons—changes that made it heavier and more expensive, which meant fewer aircraft to stay within budget limits. As a result, some squadrons would be left without replacements unless a cheaper fighter was developed. The Air Force made it clear that any LWF procurements would be in addition to the F-15 orders, essentially terminating any serious opposition to the new fighter.

The idea of a small, highly maneuverable fighter gained political support under Deputy Secretary of Defense David Packard, who favored awarding development contracts to two companies and having them build full prototypes that would participate in a "fly before you buy" competition. In January 1972, proposals were sought for a fighter with excellent acceleration, turn rate and range in the 20,000-pound weight class. The goal was to design an aircraft that could be produced in sufficient quantities for a unit cost significantly less than the F-14's and F-15's. There was no commitment that a production contract would ever be awarded after the prototypes were built and tested.

In February 1972, Lockheed, General Dynamics, Boeing, Northrop and Ling-Temco-Vought (LTV, later Vought) submitted proposals. Two months later, General Dynamics and Northrop were selected to build two prototypes each. The General Dynamics YF-16 was designed by an engineering team led by Bob Widmer. Northrop's YF-17 was based on its twin-engine P-530 design, an evolutionary version of the F-5 that would fly at Mach 2. Walt Fellers, manager of advanced systems and a key player on the P-530, was selected to lead the Northrop development program.

The F-18 Super Hornet on active duty

A major highlight of the prototyping philosophy used in the LWF program was its emphasis on achieving performance goals rather than strict adherence to detailed design specifications. Contractors were given wide latitude to innovate and create new technical solutions in order to meet or exceed the basic contract parameters. This approach represented a radical departure from traditional government procurements that contained lengthy statements of work and oppressive documentation requirements. It also encouraged the contractors to take risks and make tradeoffs to maximize overall performance.

The result was two completely different fighters that significantly advanced the state of the art for high-performance aircraft. The YF-16, with its single engine and "coke bottle" fuselage profile, was the small, nimble fighter envisioned and long advocated by John Boyd. The YF-17, with its twin-engine/twin-stabilizer design, had the hooded look of a cobra with its prominent leading-edge wing extensions. Such significant design differences would not have been conceivable without the flexibility of the prototyping philosophy. The payoff was two excellent fighters that could be evaluated against real goals, rather than columns of numbers on a spec sheet.

Built to sustain 9G turns, the YF-16 featured two innovations designed to dramatically increase pilot tolerance to high G-forces: a side-mounted control stick and a seat that was reclined at a 30-degree angle, double the angle of contemporary fighters. The aircraft also offered unprecedented visibility due to its frameless, bird-proof bubble canopy. It provided an unobstructed 360-degree visual field with a 40-degree look-down angle to either side of the aircraft. The Pratt & Whitney F100-PW-200 turbofan, the same power plant used in the F-15, was rated at almost 24,000 pounds' thrust with full afterburner, which gave the YF-16 a thrust-to-weight ratio greater than 1.0, allowing it to accelerate in vertical flight.

The YF-17 featured high-strength aluminum alloys as its primary fabrication material, and employed titanium and steel in space-limited areas of high loading and temperatures. To save weight, graphite-epoxy composites were used for the engine bay doors and several other access doors and panels. Two independent hydraulic systems, each driven by one engine, supplied mechanical power. Flight control was via a combination of hydraulics and fly-by-wire electronics. Its two General Electric YJ-101-GE-100 turbojet engines with afterburners each provided almost 15,000 pounds of thrust and a thrust to weight ratio greater than 1.0.

On December 13, 1973, the YF-16 rolled out under its own power, a fact that came as a shock to many on the Northrop team. The YF-17 rollout ceremony was held on April 4, 1974, but the aircraft was tugged into its display position because it still wasn't finished. It was obvious at this point that the YF-16 would enter the flight competition phase with a significant head start.

While the official first flight of the YF-16 occurred on February 2, 1974, at Edwards Air Force Base, the prototype had actually lifted off unexpectedly 12 days earlier during high-speed ground tests. Test pilot Phil Oestricher accidentally scraped the tailplane as he raised the nose, precipitating a dangerous lateral oscillation. He made a split-second decision to take off to facilitate an

airborne recovery. After reestablishing control, he made an uneventful landing six minutes later.

The YF-17 first took to the air on June 9, 1974, with Northrop test pilot Hank Chouteau in the cockpit. Plans originally called for flight testing to continue for more than a year, but the schedule was compressed dramatically once the decision had been made to enter full-scale production with the winner. The European consortium was angling for a decision by December 1974, while the Air Force had planned to make its choice in May 1975.

The fly-off consisted of putting both aircraft through a series of ground and aerial tests, and recording performance data that would be compared head-to-head. While the prototypes never engaged in mock combat against each other, they did fly against contemporary USAF and Soviet fighters.

The test results demonstrated that both aircraft were worthy competitors for the production contracts. Each fighter won certain phases and categories—confirmation that the mission goal approach had resulted in design tradeoffs that achieved the best overall performance. Both companies had produced relatively inexpensive, lightweight, highly maneuverable air superiority fighters. Civilian and military pilots who flew the prototypes heaped praise on the airplanes, declaring them "fighter pilot's fighters."

Flight testing was completed ahead of schedule in January 1975, after which Secretary of the Air Force John McLucas announced that the YF-16 had been selected as the future air combat fighter. The reasons given were greater maneuverability, superior acceleration and climb rates, better range, lower purchase cost, lower operating costs and the utilization of a proven engine.

The fact that the YF-16 used the same Pratt & Whitney engine as the F-15 gave it a decided advantage. In addition to lower unit costs, there would also be a considerable savings in maintenance, since the same technicians and spare parts could be used on both aircraft. The Air Force announced that it would order at least 650 of what was now called the F-16 Fighting Falcon, with the order growing to as many as 1,400.

The news was devastating to Northrop, especially the team that had nurtured the YF-17 from its infancy. But the U.S. Navy and other countries were still potential customers. Rumors spread that the Navy was not interested in the F-16 despite intense pressure from Washington for a common buy with the Air Force. Most Navy pilots favored twin engines when flying over open water, and they needed a fighter that would fill both ground-attack and air-to-air missions. Secretary of Defense James Schlesinger directed the Navy to further evaluate the two competitors with an eye toward maximizing the new technologies evolving from the LWF and reducing overall costs.

The idea of the Air Force and Navy sharing a common fighter platform looked promising on paper, and the F-4 had certainly proved the feasibility of the concept. That idea was carried to the extreme with the production of the General Dynamics F-111, which failed to satisfy either service. By compromising on critical elements such as weight, power and mission configuration, the F-111 did not provide the maneuverability and performance needed to successfully engage enemy fighters. Only seven naval F-111Bs were produced before the program was shut down. When it came to the Lightweight Fighter, the Navy would not forget this experience of having an airplane it didn't want stuffed down its throat by the Defense Department.

Northrop, which had never built a naval fighter, knew that it could not be competitive without a partner that had extensive experience with carrier-based aircraft. The company formed an alliance with McDonnell Douglas to submit its proposal to the Navy. While the designers retained the same basic configuration, they realized the YF-17 would need to be modified with a widened and beefed-up landing gear to withstand the rigors of carrier operations. Folding wings and catapult attachments would be added, and the entire undercarriage, airframe and arrestor hook had to be strengthened.

As prime contractor for the F-4, McDonnell Douglas possessed the expertise to make the new fighter a success. The two companies agreed to evenly split the parts manufacture, with McDonnell Douglas doing final assembly. In turn, General Dynamics teamed with Ling-Temco-Vought, the prime contractor for the A-7 Corsair II, to propose a carrier-optimized version of the F-16.

The Navy fought for and won Congressional approval in May 1975 to pursue development of the F-18 Hornet, as the navalized YF-17 was known. McDonnell Douglas would produce the Hornet, with Northrop as associate contractor for the airframe. It made its first flight on November 18, 1978, and became fully operational in January 1983, when it was redesignated the F/A-18, in recognition of its fighter/attack role.

Both aircraft have figured prominently in numerous military actions since the early 1980s and have compiled exceptional combat records. Away from the battlefield, the F/A-18 was adopted by the Blue Angels 25 years ago, and the Thunderbirds have been flying F-16s for almost three decades.

Over the years, both fighters have gone through several block changes that added advanced avionics and significant improvements to armament capability. The latest version of the F/A-18, called the

Super Hornet, is an extensive redesign that is 25 percent larger and has replaced the aging F-14s.

The fighters' continued stellar service more than 35 years after the introduction of their prototypes is a testament to the soundness of their designs. In retrospect, both of these innovative fighters have become legends in the annals of jet aviation. ☑

The author was assigned to the Northrop Air Force Plant Representative Office after graduating from USAFA on 06 June 1973. He served as part of a six-man team that monitored the YF-17 development in support of the Aeronautical Systems Division at Wright-Patterson Air Force Base. He also witnessed the first flight at Edwards AFB.

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