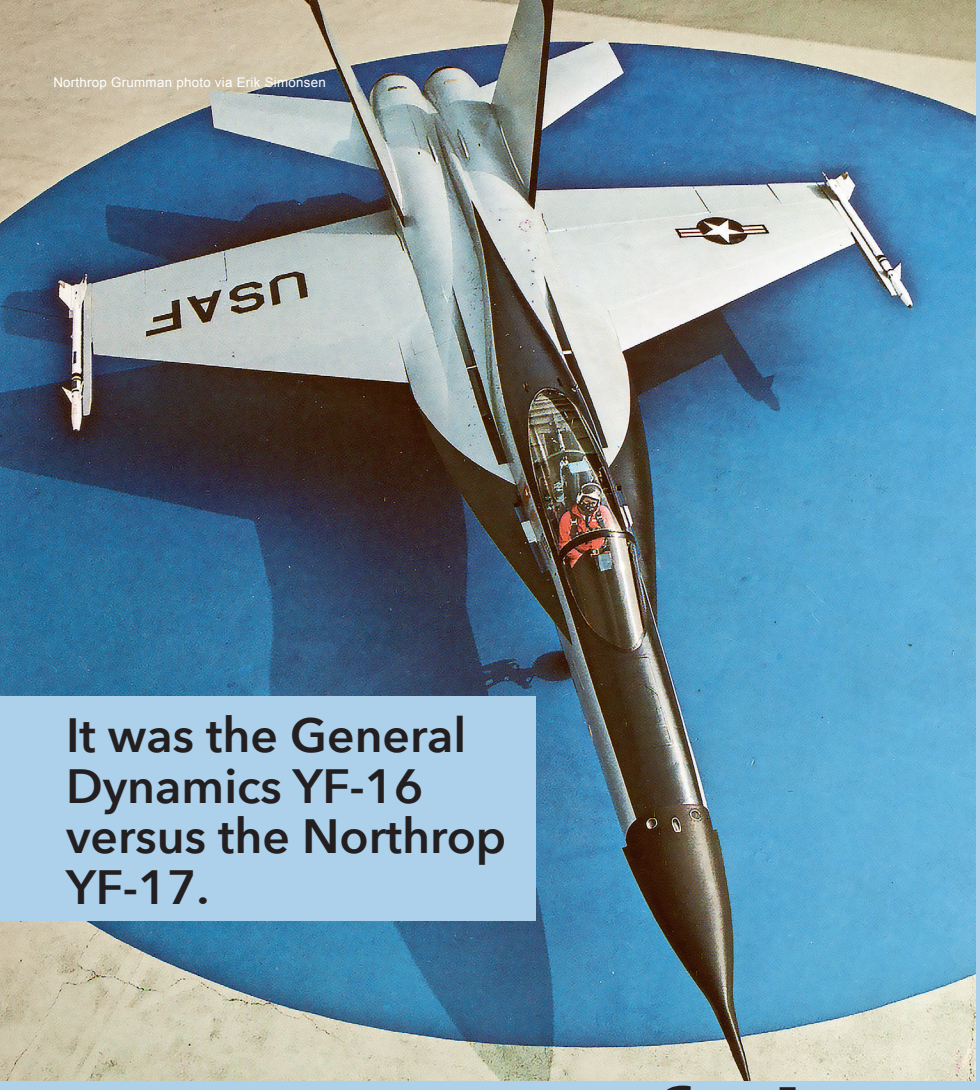

Northrop Grumman photo via Erik Simonsen

It was the General Dynamics YF-16 versus the Northrop YF-17.

Legacy of the Lightweight Fighter Competition

By Erik Simonsen

When the Air Force F-15 and Navy F-14 were being developed in the early 1970s, their performance—especially their speed and radar detection range—was unprecedented, and so was their price. Congress shuddered at the idea of such expensive machines being the fighter mainstays of the two services and directed the Air Force to explore less costly aircraft that could complement the F-15 and, later, the F-14.

From that challenge eventually grew two of the most successful fighter programs in history, each now in service nearly 40 years: the F-16 and the F/A-18. Both have already achieved a combined production of more than 6,000 airframes.

The Air Force's Prototype Program Office at Wright-Patterson AFB, Ohio, launched the Lightweight Fighter (LWF) program in January 1972. The request for proposals specified a highly maneuverable fighter, with emphasis on reduced weight and cost. This was to be a technology exploration; the LWF program didn't commit to production, but to add some

Left: A prototype of Northrop's YF-17 offering, the Cobra, would go on to become the Navy's F/A-18. Below: General Dynamics' prototype YF-16. The design would become the Air Force's F-16.

Lockheed Martin photo

cost realism, USAF set a flyaway price goal of $3 million per aircraft in 1972 dollars, based on a notional production run of 300 aircraft at a rate of 100 a year. The whole structure was an answer to Congress' insistence on a fly-before-buy acquisition approach.

Contractors were given considerable latitude in their offerings—remarkable in an era when the Pentagon had a reputation for overspecifying solutions. Unlike previous competitive fly-offs, each company would conduct an independent, one-year test program beginning with their design's first flight.

Five major contractors competed for the LWF. They were Boeing, General Dynamics, Ling-Temco-Vought (LTV), Lockheed, and Northrop.

In April 1972 the Air Force picked its two finalists. General Dynamics and Northrop would each build two prototypes of their designs, called, respectively, the YF-16 and YF-17.

Both companies took full advantage of the freedom to innovate, producing two divergent and unconventional configurations. General Dynamics came up with a blended airframe featuring a single engine and a bubble canopy offering unparalleled visibility to the pilot. Northrop's design was a two-engine, twin-tail concept with a large leading edge extension suggesting a hooded cobra—hence its name Cobra.

In an attempt to reverse persistent cost increases for complex multimission fighters, in April 1974, Defense Secretary James R. Schlesinger ordered the services to explore a low-cost Air Combat Fighter, saying the ACF could possibly emerge from the successful development of one of the LWF prototypes. The LWF/ACF program results would also fit DOD's new strategy of a high-low fighter mix for the Air Force and Navy.

AN ICONIC CONFIGURATION

Although the F-16 design has evolved in many ways, its original configuration remains iconic. It combines a host of advanced technologies that had never been incorporated in previous operational fighters. To ensure success, the YF-16 design team utilized a secret weapon in the talent of Harry J. Hillaker, who became the deputy chief engineer. Hillaker was a member of the renowned "Fighter Mafia" group of aeronautical experts and was later referred to as "the father" of the F-16.

Hillaker's career began in 1941 at Consolidated Aircraft Corp. (later Convair) with the conceptual design of the B-36 Peacemaker. He also influenced the design of the supersonic B-58 Hustler and the variable-geometry wing F-111 Aardvark.

The YF-16 was an entirely new animal, with blended-fuselage variable-camber wings and forebody strakes that provided additional lift. The wingspan was 32 feet 10 inches with a length of 49 feet six inches. It would use the Pratt & Whitney F100 engine being used on the F-15. A fly-by-wire system would provide excellent response, simplify the electronics systems, and eliminate heavier hydraulic assemblies. Fly-by-wire controls allowed for an aircraft inherently unstable to have increased agility. The YF-16 featured a side-mounted control stick and a head-up display that presented flight information such that the pilot wouldn't have to look down into the cockpit and would potentially never take his eyes off the target. The pilot's seat would be reclined 30 degrees to help him absorb heavy G forces, and the large bubble canopy offered nearly 360 degrees of visibility. Although explored piecemeal in other aircraft types, as a package in the YF-16, these innovations offered unprecedented agility and situational awareness. The YF-16 conformed to the LWF strategy, weighing 14,023 pounds, equipped with two AIM-9 Sidewinder air-to-air missiles.

The first YF-16 rolled out of the General Dynamics plant at Fort Worth, Texas, on Dec. 13, 1973, its unique, futuristic shape accentuated by a colorful red, white, and blue color scheme. Media coverage was extensive, fostering intense interest in the new lightweight generation of fighters.

The airplane was eager; an unplanned first flight occurred on Jan. 20, 1974. General Dynamics test pilot Phil F. Oestricher was making a high-speed taxi test at Edwards AFB, Calif., when the YF-16 lifted off the runway, with the right horizontal stabilizer scraping the runway's surface. Quickly reacting, Oestricher increased thrust and continued the takeoff rather than aborting. The unexpected flight lasted about six minutes and the jet landed without incident. The YF-16 intentionally flew for the first time on Feb.

The two Lightweight Fighter offerings carry AIM-9 Sidewinder missiles near Edwards AFB, Calif., in December 1972.

USAF photo via Erik Simonsen

USAF photo

Two F-16s and two F-106s fly in formation. The F-16 was chosen by the Air Force to replace aging F-106 interceptors and F-4 multirole fighters.

2. Oestricher flew a flawless 90-minute sortie, cycling the gear and reaching 30,000 feet with an airspeed of 345 mph. The side-control stick performed well through three-axis maneuvers and turns limited to three Gs at 15,000 feet. Low-speed handling characteristics were tested at an equivalent altitude with the landing gear down.

During the debrief, Oestricher said the jet was responsive, and acceleration to maximum planned speed "was accomplished very quickly." He praised the "outstanding visibility" afforded by the single-piece canopy, something he said will "impress all fighter pilots."

After General Dynamics' company pilots put the YF-16 through its basic paces, USAF pilots began their evaluations. Eventually, test pilot groups were rotated between the competing YF-16 and YF-17. Their detailed reports on technical and performance merits would drive the Air Force's final decision on the winning contractor.

In November 1974, about a month before the competition's conclusion, the two YF-16s had amassed 376 flight hours, including 12 hours at supersonic speed, up to Mach 2. The jets topped out at just over 60,000 feet. Aerial gunnery with towed targets and strafing on the Edwards range resulted in the firing of over 12,500 20 mm rounds from the M61 Vulcan cannon. Live testing of the AIM-9 Sidewinder and Mk 84 bomb drops had been conducted, and air-to-air tactics and air combat maneuvering had been flown against contemporary fighters such as the F-4E Phantom II.

One tweak made after the evaluations was to the side-stick controller. Its force-sensing mechanism offered the pilot no movement, thus preventing a true feel for the flight controls. Eventually, it was modified with a little "give" to resolve the problem.

When the LWF program got underway, Northrop was already well along with a potential successor to its successful F-5 export fighter. Its P530 Cobra, then in development, made a fairly good match to the LWF specifications and gave Northrop a head start. Company leaders planned to pursue the LWF contract while marketing the P530 in the international arena. Refining the design to make an even better LWF match, Northrop designers came up with P600. Though Northrop marketed the P600 aggressively, it earned no sales. Eventually, the best attributes of the P600 were incorporated into the YF-17 prototype.

The 56-foot-long YF-17 featured an aerodynamically curved wing with a span of 35 feet and twin vertical tails canted outward. The wing and fuselage were joined by leading edge extensions

USAF F-16 pilots prepare for takeoff on the flight line at Camp Lemonnier, Djibouti, in November. The F-16 has been in service for almost 40 years.

USAF photo by SSgt. Kenneth W. Norman

(LEXs) that essentially doubled the main wing lifting capability and served to channel air directly into the intakes during high angle-of-attack maneuvering. Features transferred from the P600 included a two-dimensional fixed ramp inlet replacing the fixed cone inlet. The twin General Electric YJ101-GE-100 engines were rated at 15,000 pounds of thrust each in afterburner. The LEX contour was further refined according to the area rule, and the wing area was reduced to 350 square feet to improve transonic/supersonic performance. The overall jet weighed 23,000 pounds.

Northrop rolled its futuristic YF-17 Cobra out of its Hawthorne, Calif., plant on April 4, 1974. Describing the company's accomplishments producing the low-cost T-38 Talon, F-5A/B Freedom Fighter, and the F-5E Tiger II, Northrop President Thomas V. Jones remarked, "These aircraft demonstrate the successful 20-year evolution of Northrop's application of technology to design advanced fighters at a cost which has permitted procurement of the aircraft in necessary quantities."

A FIGHTER PILOT'S FIGHTER

The sleek YF-17, in overall silver paint, first flew on June 9, 1974, at Edwards. Northrop Chief Test Pilot Henry E. Chouteau was at the controls and flew the jet for 61 minutes. During the flight the YF-17 reached 610 mph at an altitude of 18,000 feet. During the debrief an enthusiastic Chouteau remarked, "When our designers said that in the YF-17 they were going to give the airplane back to the pilot, they meant it. It's a fighter pilot's fighter." Two days later, on June 11, Chouteau flew the YF-17 to Mach 1 in level flight at 30,000 feet without afterburner—a technique later to be known as supercruise.

By December 1974 the No. 1 prototype had logged more than 185 hours during 159 flights, and the second prototype about 91 hours during 71 test flights. Nine hours of supersonic flight time had been accrued, up to and exceeding Mach 2. YF-17 No. 1 verified the flight-control system, stability testing, and 20 mm cannon firing, while No. 2 was flown to 100 percent of design air loads, with the General Electric YJ101-GE-100 performing exceptionally throughout all flight parameters.

The Air Force wrapped up its flight evaluations of both competitors by late 1974, and on Jan. 13, 1975, Air Force Secretary John L. McLucas announced that the General Dynamics YF-16 was the winner.

During the Pentagon press conference, McLucas said the flight test program on the two types of jets "went extremely well," and he said there were "significant differences in the performance of these prototypes." The YF-16, he said, had performance advantages over the YF-17 in "agility, in acceleration, in turn rate, and endurance." The YF-16 "met all performance goals that we had established for it."

The Air Force statement was intended to confirm a clear winner. However, Northrop's loss of the LWF didn't spell the end of the Cobra. The Navy had a preference for twin-engine aircraft for carrier operations, to offer pilots a better chance to recover an aircraft if an engine was out. The Navy was already considering a lightweight fighter to complement the larger and more complex Grumman F-14 Tomcat in a high-low mix.

The new program was dubbed VFAX and the resulting jet would replace Navy/Marine Corps F-4 Phantoms, F-8 Crusaders, and A-7 Corsair IIs.

Although several contractors were working on proposals that fit naval aircraft carrier requirements, Congress

Two F-16s over the coast of southern Florida on their way to a deployment at NAS Key West, Fla., to train with Navy F/A-18 pilots.

USAF photo by TSgt. Jeffrey Allen

USN photo by Petty Officer 3rd Class Nathan T. Beard

An F/A-18F Super Hornet taxis across the flight deck of USS *Dwight D. Eisenhower* on a deployment for Operation Inherent Resolve in November. The Super Hornet first flew in 1995.

unexpectedly opted to reduce procurement costs and redundancy and canceled VFAX. In Congress' view, the YF-16/YF-17 LWF/ACF competition would yield a suitable aircraft.

Northrop entered discussions with McDonnell Douglas, a contractor with extensive experience building carrier aircraft. Under an agreement between the two companies, the YF-17 evolved into the NACF (Navy Air Combat Fighter), a jointly developed air combat fighter for the Navy. McDonnell Douglas would become the prime contractor to offer an aircraft to meet NACF requirements. Northrop, meanwhile, would be a partner on the NACF and the leader on a ground-based YF-17 variant to be offered to NATO nations and other allies.

At the same time, General Dynamics teamed with Vought (LTV) to navalize the YF-16. The YF-16's single engine was an issue, and other factors such as reduced landing approach speed and strengthened fuselage/landing gear all required modifications and added weight.

Both General Dynamics and Northrop presented NACF proposals to the Navy. In General Dynamics' case, it offered three separate variations of its navalized F-16.

THE US NAVY AND BEYOND

On May 2, 1975, the Navy announced it had chosen the F-17 variant as its new lightweight fighter.

The F-17 then evolved into the F/A-18A, the F/A designation coined by the McDonnell Douglas/Northrop team to suggest a multirole fighter/attack aircraft. Though it looked much like the YF-17 from a distance, the new jet was beefier, with bigger engines, a bigger nose, a fatter LEX, sawtooth wing leading edges, different intake geometry, heavier landing gear, and of course, an arresting hook system.

Though a planned "F-18L" land-based version didn't sell and never entered production, F/A-18As were sold to foreign air forces for land-based operations.

The General Dynamics F-16 transitioned from the prototype aircraft to a full-scale development (FSD) production aircraft. The Fort Worth production line was configured to produce the first eight FSD F-16As. During operational test, early FSD F-16As with black radomes were quickly detected at great distances by Aggressor pilots during dogfights. Subsequently, all F-16 radomes were coated with specially formulated gray paint to blend with the two-tone gray camouflage applied to the fleet.

The first F-16A Block 1 (serial No. 78-0001) was flown at Fort Worth in August 1978 and was delivered to the Air Force during the same month. Initial operational capability (IOC) was declared on Oct. 1, 1980. A rapidly paced program, the F-16 was officially named the Fighting Falcon, but pilots preferred the name "Viper" (borrowed from fighter spacecraft in the "Battlestar Galactica" TV show popular at the time), and it stuck, unofficially.

Meanwhile, the Navy/Marine Corps procured the F/A-18. Navy Secretary William Graham Claytor Jr. bestowed the name Hornet on the type in March 1977. With McDonnell Douglas test pilot Jack E. Krings in the cockpit, the No. 1 F/A -18A made its official maiden flight on Nov. 18, 1978. The type was later upgraded with new avionics and other changes that prompted production Hornets to be designated F/A-18C and D (for one- and two-seat versions).

The F-16 design proved so iconic and versatile that it spawned an extensive number of variants.

After being damaged in a landing accident on Rogers Dry Lake at Edwards, the No. 3 F-16 was modified with a two-seat cockpit and reconfigured with a cranked-arrow delta wing. Redesignated F-16XL, and joined by a single-seat version converted from the No. 5 jet, the new configuration competed with the F-15E Strike Eagle in the 1981 Air Force Enhanced Tactical Fighter (ETF) competition. The F-15E won that contest.

Photo by David Raykovitz

A United Arab Emirates F-16E takes off from NAS JB Fort Worth, Texas. The UAE operates some of the world's most advanced F-16s.

With a trapezoidal wing, the F-16XL was later resurrected as the Falcon 21 for an F-16 upgrade program that didn't materialize.

In 1978 the sixth FSD aircraft was converted into the Advanced Fighter Technology Integration (AFTI) F-16 testbed. The AFTI investigated several new ideas, including electric actuator technologies that would be used on the future F-35.

In 1984, General Dynamics offered the Agile Falcon variant, featuring a 25 percent increase in wing area and an innovative technology infusion. It was later proposed as a lower-cost alternative to the Advanced Tactical Fighter program, but when USAF rejected the idea, the Agile Falcon's technology was adapted and later incorporated into Japan's Mitsubishi/Lockheed Martin F-2 fighter.

After the Navy's failure with the A-12 Advanced Technical Aircraft stealth attack plane in 1991, the service needed a quick way to populate its flight decks with a credible strike platform. The service decided the fastest way to do the job—and save a lot of money on ground gear, spares, and training—was to grow the Hornet into a larger aircraft with more weapons-carrying ability, longer range, and better sensors.

MERGERS AND UPGRADES

Thus was born the Super Hornet. It first flew in November 1995. The F/A-18E was the single-seat version, and the F/A-18F was a two-seater with a weapon systems officer in back. The Super Hornet was a dramatic upgrade, with a 25 percent increase in wing area, a Multifunctional Information Distribution System (MIDS), APG-73 advanced radar, and Advanced Targeting Forward Looking Infrared (ATFLIR). The pilot was equipped with the Joint Helmet Mounted Cueing System (JHMCS). It allows pointing weapons without turning the aircraft. In addition, large trapezoidal intakes infused with radar-absorbing technology fed two uprated General Electric F414-GE-400 engines generating 22,000 pounds of thrust each. The Super Hornet offered a 40 percent increase in range and loiter time versus the earlier version. The first Super Hornet was delivered in December 1998, and IOC was achieved in September 2001.

The LWF's evolution into the ACF for the Air Force, and the NACF for the Navy, was truly exceptional. In a 1990 article written for the Society of Experimental Test Pilots, Northrop test pilot Paul Metz stated, "Both Northrop and General Dynamics were asked to build a new fighter unconstrained by conventional design criteria while using existing technology," and in that "the LWF program was successful."

Through various mergers and acquisitions the contractors' names have changed. General Dynamics sold its Fort Worth military aircraft division to Lockheed in 1993, and when the company merged with Martin Marietta, it became Lockheed Martin in 1995.

McDonnell Douglas's merger with Boeing in 1996 gave Boeing a heavy fighter presence with the F-15 and F/A-18.

More than 4,570 F-16 multirole fighters in blocks 10 through 60 have been produced for some 30 countries, and more than 1,550 Hornets and Super Hornets have been built, along with more than 100 EA-18G Growler electronic attack variants.

Lockheed Martin continues to upgrade the F-16 for all its customers. The latest F-16V took to the air in October 2015. This variant features a fifth generation APG-83 active electronically scanned array fire-control radar, advanced mission architecture, and numerous cockpit improvements.

Together, the YF-16 and YF-17 created the fourth generation of fighter aircraft that today are the most numerous examples of the class. The Lightweight Fighter competition gave rise to two winning aircraft designs that have each created an extraordinary legacy. ✪

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