Similarly, the C-130J Super Hercules cockpit features flat panel color displays that provide much more information than its predecessors. Night vision-compatible lighting and two head-up displays as primary flight instruments are two of many other improvements that increase the capability of this latest version of the C-130.

Many of the photos in this collection were taken specifically for this special issue of Code One. Photojournalist John Rossino, Associate Editor Jeff Rhodes, and I were given special access to get these pilot’s-eye perspectives. I had the unique pleasure of climbing into the belly of a Consolidated PBY Catalina hanging from the ceiling of the National Museum of Naval Aviation to take the photo on page six. Squeezing through the innards of the B-24 Liberator and the B-36 Peacemaker to get to their cockpits was memorable as well.

With these memories in mind, the Code One staff sends a special thank you to the volunteers and staff at the National Museum of the US Air Force at Wright-Patterson AFB in Dayton, Ohio, and at the National Museum of Naval Aviation on NAS Pensacola, Florida, for their assistance in capturing many of these images. We encourage readers to visit these great institutions to view these aircraft—from the outside, anyway—in person. Thanks also to Vinny Devino, whose career designing aircraft cockpits spanned more than forty years, and to Ken Thomas, who served as the F-22 cockpit integrated product team manager. They provided insight into the design behind the historic cockpits.

We also invite readers to provide additional photos and insights on Lockheed Martin legacy cockpits. We plan to post additional images on www.codeonemagazine.com.

Enjoy,

Editor
The F-35 Lightning II is a multinational, multiservice, single-pilot fighter designed with first-day-of-the-war, precision all-weather strike capability. This highly survivable fighter will be built in three variants—conventional takeoff and landing, short takeoff/vertical landing, and carrier-based. Overall, the F-35 cockpit is a generation beyond preceding aircraft, as large liquid crystal touch-screen displays feature color-coded symbology, pictographs, and digital information. Also, the head-up display has been replaced by a helmet-mounted display as the primary flight reference. The complexity of missions, sensors used, and weapons employed make this fifth-generation cockpit necessary. Advanced technology makes it possible.
The MB-2 was the first US-designed bomber to be procured in quantity. Gen. William (Billy) Mitchell used the MB-2 in July 1921 to sink three ships in tests off the Virginia Capes. The trials, which included sinking the captured German battleship Ostfriesland and the former USS Alabama, demonstrated the concept of aerial bombardment and highlighted the vulnerability of naval vessels to attack from the air. The cockpit reflected early 1920s technology. The large control wheel was the result of the completely manual, unboosted cable and pushrod control systems of the era. The open cockpit had no windscreen.
The F-111 Aardvark fighter-bomber is the world’s first operational aircraft with variable geometry, or swing, wings. Born in controversy, the F-111 proved to be one of the best all-weather interdiction aircraft ever built. On 15 April 1986, this F-111 led the US Air Force portion of Operation El Dorado Canyon, the retaliatory raid against Libya in response to that country’s state-sponsored terrorism. The crew module escape system, in which the entire cockpit is ejected, led to the side-by-side crew arrangement. The weapons systems officer in the right seat has a control stick, but limited flight instruments.
The Constellation was a highly versatile commercial airliner and military transport aircraft, regarded by many aviation enthusiasts as one of the most beautiful aircraft ever built. The Model 749, the fifth major Constellation variant, was specifically designed for transoceanic airline operations. It served as the basic airframe design for President Dwight Eisenhower’s VC-121B and the Navy’s two PO-1Ws, the first airborne early warning aircraft. The cockpit reflects technology typical for military and civilian transports of the period with dedicated displays and indicators and a center console dominated by engine controls. The large elevator trim wheel indicated unboosted cable controls.
The C-5M Super Galaxy is the product of two major C-5 modification programs: the Avionics Modernization Program, or AMP, and the Reliability Enhancement and Re-engining Program, or RERP. The complementary modifications to the C-5 are expected to extend the life of the fleet until 2040 and save the US government more than $49 billion in operations and sustainment costs over the remaining life of the aircraft. The AMP modification replaces the earlier analog avionics in the Galaxy with a commercially available digital suite along with an integrated architecture that allows for upgrades. The RERP modification includes new engines and more than seventy other system and aircraft upgrades.
The PBY Catalina was the primary flying boat operated by Allied forces in World War II, serving on all fronts around the world. It was used for long-range scouting and anti-submarine patrols, convoy escort, search and rescue missions, and bombing operations. It is the world’s most produced and most widely used seaplane. This Catalina is the only non-amphibious PBY-5 known to exist. Mission durations of up to twenty hours were routine and could be extended to twenty-four hours and were limited only by crew fatigue. Engine and propeller controls were mounted overhead to provide the shortest cable routing to the engines.
Two variants of the P-3 Orion maritime patrol aircraft are flown by US Customs and Border Protection, the nation’s first line of defense in the war on illegal drug trafficking. The agency’s airborne warning and control and long-range tracker aircraft detect drug smugglers and coordinate with other assets. They act as the on-scene commanders when a smuggler is stopped and arrested. Both types of Customs P-3s have digital cockpit instrumentation similar to a 737-800 commercial airliner. The pilot has a monitor that repeats images from radar scopes monitored by sensor operators stationed aft of the cockpit.
The P-38 Lightning was a twin-engine, high-performance fighter flown by US Army Air Corps pilots in every theater in World War II. With its unusual twin tail booms and counter-rotating propellers, the P-38 is one of the most well-known and recognized aircraft in history. The Germans nicknamed it *der Gabelschwanz Teufel*, or “the fork-tailed devil.” The top two American aces of all time, Majs. Dick Bong (forty victories) and Thomas McGuire (thirty-eight victories), both flew P-38s in the Southwest Pacific. An unusual feature is the pilot’s control yoke, which was not typical in other US fighters of the period.
The F-104 Starfighter was the first operational fighter capable of sustained speeds above Mach 2. Known as “the missile with a man in it,” the Starfighter was also the first aircraft to hold simultaneous world records for speed, altitude, and time to climb. Most Starfighters built were flown by thirteen Allied countries. This aircraft was used to win the 1962 William Tell fighter weapons meet held at Tyndall AFB, Florida. Early versions of the F-104 had side-opening canopies and downward-firing ejection seats, which were thought to be required to avoid the aircraft’s vertical T-tail during an ejection.
The US Marine Corps evaluated the C-130 as a tanker in 1957, just three years after the Hercules was first flown. In 1963, this KC-130F was used to make twenty-nine touch-and-go landings and twenty-one full-stop landings on the USS Forrestal (CVA-59) without arresting gear to test the feasibility of a large carrier onboard delivery aircraft. After a forty-two year career, including service in Vietnam, Afghanistan, and Iraq, it was retired in 2005. The cockpit layout is typical for the late 1950s, with the center of the instrument panel dominated by engine instruments and controls, although this cockpit shows that it was modified over its service career.
The infusion of technology in the flight deck of the C-130J Super Hercules airlifter reduces crew and operations costs and increases reliability and performance. The Super Hercules features dual head-up displays; a 1553B data bus architecture; digital avionics; four color multifunction liquid crystal displays compatible with night vision imaging systems; autothrottles and dual autopilots; dual mission computers; an integrated diagnostics system; an integrated communications/navigation system with dual GPS and inertial navigation systems; color weather/ground mapping radar; and a color, digital moving map display. Newer technology allows a cleaner cockpit than earlier C-130s.
The A-12 was the secret, Mach 3+, high-altitude, long-range follow-on to the U-2 reconnaissance aircraft. It was developed for the CIA under the code name Oxcart. The A-12 was a technological leap—in aerodynamics, engines, cameras that worked at altitudes above 90,000 feet, fuels, pilot life-support systems, materials, and manufacturing. The radar scope at the top of the instrument panel required a hood so the single pilot could view the reconnaissance imagery in daylight. The physical limitations of the pilot’s full pressure suit and helmet account for the placement of the attitude indicator high on the panel.
Although designed as the US Navy’s last dedicated carrier-based anti-submarine warfare aircraft, the S-3 Viking became a jack-of-all-trades platform, taking on carrier onboard delivery, fleet tanker, electronic surveillance, and precision attack roles. On 1 May 2003, this Viking served as the first-ever Navy One, being used to fly President George W. Bush to the USS Abraham Lincoln (CVN-72) for a televised speech. The overall external visibility afforded the crew was excellent and provided the basis for subsequent military standards (MIL-STD-850) for this class of aircraft. The Viking picked up the nickname “Hoover” for the unique sound of its engines when taxiing.
Desert Hawk is the flying portion of the Force Protection Airborne Reconnaissance System. It has a fifty-two inch wingspan and carries one-pound payloads aloft for extended periods. The aircraft, powered by an electric motor, acts as a flying sentry, quietly surveying large areas with three internally mounted video cameras and an infrared imaging system. It is linked real-time to a ground station. Flight paths are set through a laptop computer, but the aircraft navigates autonomously. An “orbit here now” button immediately sends Desert Hawk into a circular flight pattern and simultaneously trains the cameras to the center of the orbit.
The T-50 Golden Eagle is the supersonic advanced jet trainer now in service with the Republic of Korea Air Force. The Golden Eagle was developed through a partnership between the South Korean government, Korea Aerospace Industries, and Lockheed Martin. The aircraft is the first new dedicated supersonic trainer in more than two decades. The cockpit features hands-on throttle and sidestick, electronic flight instruments and color multifunction displays, head-up display, GPS/INS navigation, embedded training capabilities, in-flight recording and a post-mission debriefing capability. All of these features combine to ease the transition from trainer to modern fighters, such as the F-16 or F-22.
The AM-1 Mauler was one of the first aircraft designs for the US Navy to combine the two mission roles of scout/dive bomber and torpedo bomber after World War II. The Mauler, powered by a 3,000 hp engine, lived up to its nickname by carrying four 20 mm cannons and having fifteen hardpoints under the wings and fuselage for munitions. Often referred to as “Able Mabel” from the type’s designation, the Mauler featured a relatively standard cockpit for the period. The AM-1 was difficult to land and kept even the most experienced pilots on their toes.
The F-117 is the world's first operational stealth aircraft. Through a combination of faceted surfaces, advanced materials, and other technologies, the Nighthawk is virtually undetectable to radar. With precision weapons, the F-117 can destroy heavily defended, high-value targets with impunity. Essentially designed by electrical engineers, the F-117 is inherently unstable and stays airborne through a sophisticated flight control system. The original cockpit design used many off-the-shelf components, such as F/A-18 displays. A complete set of standby flight instruments is included as a backup. Plastic glareshield extensions are used to minimize instrument reflections on the flat canopy side panes.
The F-102 Delta Dagger was the world’s first supersonic all-weather interceptor, the US Air Force’s first operational delta wing aircraft, and the first fighter with air-to-air missiles as its primary armament. At peak deployment in the mid 1950s, more than twenty-five squadrons operated the F-102. This particular Delta Dagger was among the first Air Force aircraft to intercept a Soviet Tu-20 “Bear” bomber over the Arctic Ocean. The basic cockpit layout is dominated by the radar display that required the pilot to lean forward and place his head against the rubber boot to read. A unique feature of this design was the double-headed stick grip.
The F-106 Delta Dart was the US Air Force’s last dedicated interceptor. The ground-based semiautomatic ground environment defense system allowed the Delta Dart to be flown automatically from wheels up on takeoff to landing flareout. In 1970, this aircraft entered an uncontrollable flat spin over Montana during which the pilot ejected. The aircraft amazingly recovered, circled, and made a gentle belly landing. It was repaired and flown again. With a relatively roomy cockpit, the F-106 was the first US Air Force fighter to employ vertical scale flight instruments. The sensor display was relocated lower on the instrument panel in later versions.
The original U-2 was a reconnaissance aircraft designed to operate in the thin atmosphere above 55,000 feet where it could obtain hard intelligence into Soviet activities by penetrating Soviet airspace with impunity. It was designed and built in complete secrecy at the height of the Cold War. U-2 pilots provided undeniable proof that no missile and bomber gap existed between the United States and the USSR. The yoke-configured cockpit, while unusual for a single-seat aircraft, was needed to allow the pilot easy reach while wearing a full pressure suit. Early U-2s had no ejection seat.
The second-generation U-2, originally designated U-2R, is based on the original U-2 design but is approximately one-third larger. After a gap of twelve years, the production line was reopened in 1980 for a second production run. Updated continuously over its career, the U-2Rs received new engines, a new electrical generation system, and a digital autopilot in the late 1990s and were redesignated U-2S. The current Reconnaissance Avionics Maintainability Program, or RAMP, replaces the 1960s-vintage cockpit design with three multifunction displays, an upfront control and display unit, and an independent secondary flight display system, showing how technology can unclutter a cockpit.
The B-26 Marauder medium bomber was ordered directly off the drawing board in 1939. Despite troubled development, the B-26 went on to a stellar career in World War II, primarily in Europe and the Mediterranean. It had the lowest loss rate of any Allied bomber, less than one-half of one percent. Marauder crews flew more than 110,000 sorties and dropped more than 150,000 pounds of bombs. The absence of an instrument panel for the co-pilot, along with a side-mounted yoke, provided access to the forward compartment for the nose gunner and bombardier. The displays were centrally mounted so the co-pilot could see them.
The B-58 Hustler was the first supersonic bomber put into production and the first bomber capable of reaching Mach 2. On 5 March 1962, this Hustler won the twenty-first and last Bendix Trophy transcontinental race. Called Operation Heatrise, the aircraft was flown from Los Angeles to New York in two hours and fifty-six seconds at an average speed of more than 1,200 mph. The three-man crew sat in tandem. The pilot’s instrument grouping was constrained by the aircraft’s narrow fuselage. The B-58 featured a unique ejection system that encapsulated the individual crew member prior to ejection in an emergency.
The YF-16 was the precursor to today’s F-16 multirole fighter. It originated in the US Air Force’s Lightweight Fighter technology demonstration program of the mid 1970s that emphasized low cost and high performance. Two YF-16 prototypes were flown. The aircraft won the Air Combat Fighter competition over the YF-17 in 1975. While the cockpit instrumentation is basic and analog, the YF-16 introduced the head-up display, reclined ejection seat to improve pilot g-tolerance, and sidestick controller. It also featured a hands-on throttle and stick philosophy that allows pilots to focus their attention on the tactical situation outside the aircraft instead of on switches inside the aircraft.
Over its career, the F-16 Fighting Falcon—or Viper, as it is more commonly known—has been continuously updated. Nowhere are those changes more evident than in the cockpits of the latest generation of F-16s, the Block 50/52+, and particularly the Block 60 version shown here. The latest F-16 cockpits feature color multifunction displays and lighting compatible with night vision systems. Onboard computers process information from sensors and off-aircraft sources and present information to the pilot with straightforward graphics. Still, the cockpit retains many features that made the F-16 revolutionary from the beginning, including a frameless bubble canopy, hands-on throttle and sidestick switch controls, a thirty-degree seatback angle for increased g tolerance, and a head-up display.
The TV-2 Shooting Star was the US Navy’s two-seat training version of the P-80 Shooting Star fighter. The need for a trainer became apparent early in the P-80’s development. Known first as the TP-80 and then as the T-33 in Air Force service, this aircraft was used to train thousands of pilots in the US and for more than twenty international operators. The T-33 was manufactured in the United States, Canada, and Japan. The TV-2s were adequate for jet familiarization, but were not suitable for operational training aboard carriers. TV-2s later served in several utility roles. Typical for a trainer, the cockpit instrumentation is straightforward and designed to teach students the basics of flying.
The NT-33 was a T-33 trainer modified as an inflight simulator. It used a three-degree-of-freedom, response-feedback flight control stability system to mimic the handling characteristics of other aircraft. Over its forty-year career, the NT-33 was used to perform flying qualities, cockpit display, control stick, and flight control design tests for a number of aircraft, including the X-15, X-24, A-10, F-15, YF-16, YF-17, F/A-18, F-117, and the YF-22. The systems in the NT-33 were continually updated, progressing from vacuum tubes and analog electronics to digital processors and a programmable head-up display. The cockpit is a hybrid of every generation of jet cockpits.
The B-24 Liberator was a long-range heavy bomber that saw service in every theater of World War II. The Liberator was more widely used, had longer range, and carried a larger bomb load than the more well known B-17. In six years, more B-24 bombers were built than any other American combat aircraft in history. In addition, the B-24 offered more cockpit room than the B-17. The unusual through-the-panel control yoke imposed limits on instrument placement. This B-24D, nicknamed *Strawberry Bitch*, was flown on fifty-nine combat missions from Libya and Tunisia in 1943 to 1944 with the 512th Bombardment Squadron.
The B-36 was the world’s first true intercontinental bomber. Designed in 1941 to strike European targets from North America when it seemed Britain might fall to Germany, the B-36 could carry an 86,000-pound payload and had an 8,800-mile range. The unofficially nicknamed “Peacemaker” served as America’s airborne nuclear deterrent through the 1950s. This B-36J made the type’s last flight on 30 April 1959. The expansive paneled canopy provided excellent exterior visibility. The flight engineer was tasked primarily with monitoring the “six turning and four burning” engines, that is, six radial engines turning pusher propellers and four underwing jet engines.
The F-80 was the first US Air Force aircraft to exceed 500 mph in level flight and the first American jet built in quantity. Originally designated P-80, the nomenclature was changed in 1948 when the P-for-pursuit designation was dropped. The Shooting Star was the victor in the world’s first all-jet air battle when Lt. Russell Brown shot down a MiG-15 on 8 November 1950. This aircraft is one of the few remaining Shooting Stars to see combat in Korea. The bubble canopy provided excellent visibility to the pilot, though the forward view was dominated by the optical sight.
The C-141 StarLifter was the world’s first turbofan-powered transport. StarLifter crews participated in every military and nearly every humanitarian operation on every continent for four decades. On 12 February 1973, this aircraft, then a C-141A, was flown to Hanoi, North Vietnam, in the first mission of Operation Homecoming, the repatriation of former American prisoners of war. Most of the C-141s were stretched to carry more cargo and redesignated C-141B. Starting in 1997, sixty-three aircraft, including this one, received an autopilot and cockpit upgrade, which included glass cockpit instrumentation, a GPS-enhanced navigation system, and an all-weather flight control system. These upgraded aircraft were then redesignated C-141Cs.
The F-22 is quite simply the most sophisticated fighter built. By every measure, the Raptor, the world’s first fifth-generation fighter, represents breakthroughs in maneuverability, stealth, and sensor fusion. The aircraft’s design is a balance of increased speed and range, enhanced offensive and defensive avionics, and greatly reduced observability. The F-22 will provide air dominance for the US and its allies for the next forty years. This cockpit is the first true glass cockpit with no standby mechanical gauges and only minimal dedicated controls on the console panels. Superior external visibility is provided by a canopy that is the largest piece of formed polycarbonate ever made.
**Lockheed Martin/Northrop Grumman/BAE Systems F-35 Lightning II**  
*Type:* Fighter (Multirole)  
*In Service:* Service entry expected in 2022  
*Photographer/Location:* Tom Harvey/Lockheed Martin, Fort Worth, Texas

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**Martin MB-2**  
*Type:* Bomber (Heavy)  
*In Service:* 1921–1928  
*Photographer/Location:* John Rossino/National Museum of the US Air Force

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**Lockheed Model 749 Constellation**  
*Type:* Airliner/Transport  
*In Service:* 1947–1967 (individual Connavs are still being flown today)  
*Photographer/Location:* Lockheed Martin Archives/Burbank, California

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**Lockheed Martin C-5M Super Galaxy**  
*Type:* Transport (Strategic)  
*In Service:* Scheduled for 2008 (C-5M)  
*Photographer/Location:* John Rossino/Marietta, Georgia

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**Consolidated PBY Catalina**  
*Type:* Maritime Patrol/Rescue  
*In Service:* 1936–1957 (individual Catalinas are still being flown today)  
*Photographer/Location:* Eric Hehs/National Museum of Naval Aviation

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**Lockheed P-3 (US Customs and Border Protection Airborne Early Warning)**  
*Type:* Maritime Patrol/Drug Interdiction  
*In Service:* 1984–Present  
*Photographer/Location:* John Rossino/Greenville, South Carolina

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**Lockheed P-38 Lightning**  
*Type:* Fighter (Multirole)  
*In Service:* 1941–1949  
*Photographer/Location:* John Rossino/Lockheed Martin, Fort Worth, Texas

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**Lockheed F-104 Starfighter**  
*Type:* Fighter (Interceptor, Primarily)  
*Photographer/Location:* John Rossino/National Museum of the US Air Force

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**Lockheed KC-130F Hercules**  
*Type:* Tanker/Transport (Tactical)  
*In Service:* 1960–Present (KC-130F)  
*Photographer/Location:* John Rossino/National Museum of Naval Aviation

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**Lockheed Martin C-130J Super Hercules**  
*Type:* Transport (Tactical)  
*In Service:* 1999–Present  
*Photographer/Location:* John Rossino/Marietta, Georgia

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**Lockheed T-3 Viking**  
*Type:* Carrier-Based Multimission  
*In Service:* 1974–Present (Expected US Navy retirement date in 2009)  
*Photographer/Location:* John Rossino/National Museum of Naval Aviation

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**Lockheed Martin Desert Hawk**  
*Type:* Reconnaissance Unmanned Aerial Vehicle  
*In Service:* 2002–Present  
*Photographer/Location:* Doug Clement/Eugan, Minnesota

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**Lockheed Martin A-12**  
*Type:* Reconnaissance (Strategic)  
*Photographer/Location:* Lockheed Martin Archives/Burbank, California

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**Lockheed Martin F-22 Raptor**  
*Type:* Fighter (Air Dominance)  
*In Service:* 2005–Present  
*Photographer/Location:* John Rossino/Marietta, Georgia

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**Lockheed TV-2 Shooting Star**  
*Type:* Trainer  
*In Service:* 1948–1987 (The last Air National Guard aircraft was retired in 1987; some international operators are still flying T-33s in a limited role)  
*Photographer/Location:* John Rossino/National Museum of Naval Aviation

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**Convair B-38 Hustler**  
*Type:* Bomber (Medium)  
*In Service:* 1960–1970  
*Photographer/Location:* John Rossino/National Museum of the US Air Force

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**Convair F-102 Delta Dagger**  
*Type:* Fighter (Interceptor)  
*In Service:* 1956–1979 (US Air National Guard service ended in 1977; Turkey’s last aircraft was retired in 1979)  
*Photographer/Location:* John Rossino/National Museum of the US Air Force

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**Convair F-106 Delta Dart**  
*Type:* Fighter (Interceptor)  
*In Service:* 1959–1988  
*Photographer/Location:* John Rossino/National Museum of the US Air Force

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**Lockheed C-130J Super Hercules**  
*Type:* Transport (Strategic)  
*In Service:* 1965–2006  
*Photographer/Location:* John Rossino/National Museum of the US Air Force

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**General Dynamics YA-13 Starfighter**  
*Type:* Fighter Technology Demonstrator  
*In Service:* 1978–Present (F-16)  
*Photographer/Location:* Lockheed Martin Archives/Fort Worth, Texas

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**Lockheed Martin F-16 Fighting Falcon**  
*Type:* Fighter (Multirole)  
*In Service:* 2005–Present (F-16E/F)  
*Photographer/Location:* Tom Harvey/Fort Worth, Texas

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**Lockheed P-38 Lightning**  
*Type:* Fighter (Multirole)  
*In Service:* 1941–1945 (USAAF service ended in 1945, although a limited number of aircraft saw service with the Indian Air Force until 1968)  
*Photographer/Location:* John Rossino/National Museum of the US Air Force

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**Lockheed NT-33**  
*Type:* Research and Development  
*In Service:* 1957–1997  
*Photographer/Location:* National Museum of the US Air Force

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**Lockheed Martin B-2A Spirit**  
*Type:* Bomber (Strategic)  
*In Service:* 2005–Present (B-2A)  
*Photographer/Location:* John Rossino/National Museum of the US Air Force

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**Lockheed Martin/Boeing F-22 Raptor**  
*Type:* Fighter (Air Dominance)  
*In Service:* 2005–Present  
*Photographer/Location:* John Rossino/Marietta, Georgia

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For additional information on these aircraft, go to www.codeonemagazine.com