

AVIATION VOL 2



Startup's Revolutionary Jet Engine Could Transform Air Travel

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The Innovation: [Astro Mechanica](#)'s Turboelectric Adaptive Engine uses electric motors to independently control its components, allowing it to function efficiently at any speed from takeoff to Mach 5. The design eliminates the traditional trade-offs between power and efficiency that have limited jet engine development.

- Adapts to different flight conditions
- Uses electrical power for optimal control

<https://twitter.com/k2pilot/status/1763007610993991722>

The Visionary: CEO Ian Brooke, despite lacking traditional engineering credentials, brings decades of hands-on aviation experience to the project. Starting with model aircraft at age 14, he progressed to building real planes before founding Astro Mechanica.

- Plans San Francisco to Tokyo test flight
- Targets commercial aviation market

Market Impact: The company plans to demonstrate a full-size engine model this year and integrate four engines into a 20,000-pound test aircraft. Success could revolutionize both private and commercial aviation, making supersonic travel accessible to regular passengers.

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China unveils long-range drone with 22,000-pound payload power, 575 mph speed



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New images and videos have materialized that appear to show what is believed to be the latest iteration of China's so-called *Caihong-7* (CH-7) Long-Endurance Drone [uncrewed combat aerial vehicle \(UCAV\)](#). Seen taxiing on a runway sporting a light-yellow paint scheme, these images, if true, could indicate the drone is close to completion.

Various images of the drone have appeared over the last few years, and each shows a gradual evolution in design and scale. The latest is larger than its predecessors and has other features not seen in previous iterations.

There is limited information available about the CH-7, which stands for “Rainbow-7.” However, it is known to be in development by the China Aerospace Science and Technology Corporation (CASC).

Based on the available information, it is likely that the drone is intended for high-altitude, long-endurance missions focused on intelligence, reconnaissance, and surveillance (ISR).

If true, this would mean the drone could potentially penetrate hostile airspace at high altitudes, gathering vital intel on a belligerent nation. It is not out of the question that the CH-7 could also be employed for strike missions.

CH-7 close to completion?

So far, videos and stills released by Chinese state media today show the drone on a so-far unidentified runway, taxiing down it day and night. It is important to note that no footage of it airborne has yet been seen. We cannot be entirely sure if this new drone is the [CH-7](#), but many military analysts are confident it likely is.

The drone also [appears](#) to have stealth capabilities, featuring a reduced signature dorsal engine intake rear exhaust and an internal payload bay. Its yellow coloration is seen as strong evidence that the CH-7 is likely undergoing testing, as this primer tends to be used by the nation during these phases of development.

The CH-7 was first revealed in 2018 when images of a mockup were showcased at Airshow China in Zhuhai. This early design was likely influenced by the United States’ Northrop Grumman [X-47B UCAV](#).

A later, more refined model was seen at Airshow China in 2022 with modified wing designs and an increased wingspan of 85 feet (26 meters) compared to 72 feet (22 meters) previously. The latest iteration, if indeed the CH-7, appears to have grown again, with a speculated overall length of 33 feet (10 meters).

China to export the drone?

Others have estimated that it could have a takeoff weight of 10,000 kg, a top speed of 575 mph (926 kph), and a 15-hour flight time. Other key features of the CH-7 include a dorsally mounted intake for an unidentified turbofan engine and an internal payload bay for weapons and sensors.

The CH-7's current design and stealth capabilities resemble the United States' in-development [RQ-180](#). It also shares some characteristics with other Chinese drones, like the GJ-11 "Sharp Sword."

Another interesting morsel of information could indicate that China may be open to offering the CH-7 for export. If these rumors are true, China will be positioned as a world leader and a supplier of advanced militarized aerial vehicles.

Assuming it would find willing buyers, of course. This would be more a matter of default as the United States currently prohibits export under various legislation like the "[Missile Technology Control Regime](#)" to prevent hostile nations from getting their hands on advanced U.S. technology.

The U.S. Air Force Has Much Bigger Plans Than NGAD Fighters



NGAD© Provided by National Interest

What You Need to Know: The U.S. Air Force is pursuing advanced modernization programs, including the NGAD sixth-generation fighter, CCA drone swarms, and the NGAS refueling system, to maintain air superiority amid potential conflict with China. However, the high costs of these programs are prompting difficult funding decisions.



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-Air Force Secretary Frank Kendall highlighted the fiscal challenge at the recent Airlift/Tank Association symposium, stressing that each program is interconnected and essential for countering China's growing capabilities.

-With a predicted \$300 million per NGAD fighter, Kendall emphasized the need for increased investments as modernization demands and the looming threat of a China-Taiwan conflict grow.

The U.S. Air Force is modernizing. With the 2030s coming up fast and the threat of near-peer conflict with China always on the horizon, the Air Force is working on several ambitious programs to ensure the U.S. military enjoys air superiority in a potential conflict.

Some of the programs currently in the works include the Next Generation Air Dominance (NGAD) program that will produce a sixth-generation stealth fighter jet, and the Collaborative Combat Aircraft (CCA) drone swarms, and [the Next Generations Aerial-refueling System \(NGAS\)](#).

However, the Air Force and Congress have realized that these programs don't come cheap. And with the recent "traumatic" experience with [the F-35 Joint Strike Fighter's price tag](#) of around [\\$2 trillion](#), the Air Force will need to prioritize some programs over others.

Taking-off Costs

During the Airlift/Tank Association symposium earlier in November, Air Force Secretary Frank Kendall said that the Air Force will have to find creative solutions to its future force structure due to the high costs of the programs under development.



NGAD© Provided by National Interest

"These [three potential new-design platforms](#) are all tied together, all in an Agile Combat Employment context," Kendall [said](#) about the three ongoing programs.

The Air Force Secretary stated that they are connected both in an operational setting, as well as in a fiscal one, with procurement decisions intertwined in a major way.

Air Force leaders have often said that to effectively counter China, [the NGAD](#), [NGAS](#), and CCA are all important capabilities that will help the U.S. military maintain air superiority.

“Right now, given our commitments, our resources, and strategic priorities, it’s hard for me to see how we can afford any combination of those new designs,” Kendall said.



NGAD© Provided by National Interest

Of course, Kendall’s message is as much directed to his generals as to the aerospace industry and their steep pricing. Some of the estimates for [the NGAD](#), which will replace the F-22 Raptor in the air superiority mission, put costs for each fighter jet to as much as [\\$300 million](#).

The specter of a near-peer conflict with China is always hovering in the background and influences how the Air Force makes decisions about which programs to greenlight.

"There comes a point where you simply need more resources to accomplish more missions. This is particularly true now," the Air Force Secretary added.

Kendall had recently stated that he believes that the Chinese military will be ready to invade and capture Taiwan by 2027, regardless of whether the U.S. military intervenes. That assessment aligns with statements from other U.S. defense officials about the possibility of a conflict with [China](#) over Taiwan in the upcoming years.

"Modernization bills for both Air Force legs of the nuclear triad are coming due in the next few years. We must have robust airbase defense, and we must attack our potential adversaries' long-range kill chains," Kendall stated.

"All of these are absolutely essential for the success of the Air Force and Space Force and the joint force, and all that requires substantial [sic] increased investments," the Air Force Secretary concluded.

China reveals Mach 7 hypersonic weapon design that can deploy missiles, drones



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The latest in the string of new military concepts coming from China is a hypersonic boost-glide weapon that can launch other weapons, drones of its own.

The new unpowered boost-glide weapon concept will carry sub-payloads which can be launched mid-flight to strike multiple targets. Moreover, the sub-payloads can also be used for electronic warfare, and reconnaissance operations.

A model of the concept weapon, called GDF-600, has been put on display at the Zhuhai airshow in China by the Guangdong Aerodynamic Research Academy (GARA).

According to the model presented at the airshow, the weapon can carry several sub-payloads at once. Something that significantly boosts the capabilities of the hypersonic weapon to further raise worries for any enemy.

Hypersonic boost-glide weapons consist of a maneuverable glide vehicle launched on a ballistic missile or rocket booster. Owing to their ability to keep changing their path before hitting the target, they are considered quite difficult to defend against.

The addition of sub-payloads will make the equation more complex, and it will increase the worries of any army which is up against China, if the weapon sees the light of the day.

GDF-600 – China's hypersonic boost-glide weapon concept

According to the details shared by Michael Jerdev on X (formerly Twitter), the GDF-600 concept promises to have a maximum speed of up to Mach 7 (5,370 miles per hour).

The company states that it can have a launch mass of 11,023 pounds (5,000 kg), and can carry payloads of up to 2645 pounds (1200 kg).

Further, the hypersonic vehicle can travel up to a range of 372 miles (600 km), and reach maximum trajectory altitude of 24 miles (40 km).

The company also states that it can carry five different types of sub-payloads, which can further reach varying levels of top speeds and can hit targets at varying ranges.

Prima facie, it seems that the company's sub-payloads were created to accomplish varying goals, such as reconnaissance, hitting land targets, and even those at sea.

Further, it can [also accommodate](#) several unmanned aerial vehicles (UAVs), as the model displayed at the air show reveals.

Some X users have also [pointed out](#) that the GDF-600 hypersonic [vehicle](#) seems to be based on the MD-22 test project which was unveiled two years earlier at the Zhuhai air show.

Other revelations at the Zhuhai air show

Some other innovations which are surfacing at the Zhuhai air show include a drone mothership, which is said to have a maximum takeoff weight of 10 tons, and could have the capability to launch drone swarms in the air.

The drone, [called Jiu Tian](#), which stands for 'High Sky' in Chinese, is powered by jet engines. Its design is by the government-owned Aviation Industry Corporation of China (AVIC).

Further, Beijing's latest [carrier-based warplane](#), the J-15D, was publicly showcased for the first time during an adaptive training session in Zhuhai City, in South China's Guangdong Province.

The J-15D is a two-seat electronic warfare aircraft that integrates electronic jamming capabilities with strike functions, potentially playing a vital role in combat situations.



China 6th Generation Fighter

What You Need to Know: At the 15th China International Aviation and Aerospace Exhibition, China revealed the "White Emperor," a mockup of a purported sixth-generation "space-capable" fighter. Presented as part of the Nantianmen Project, the White Emperor showcases an ambitious design meant to bridge air and space capabilities.

NGAD 6th Generation Fighter© Provided by National Interest

- The aircraft includes internal missile bays for stealth, robust landing gear for rough runways, and a structural design aimed at carrying heavier payloads.
- However, skepticism surrounds China's ability to rapidly develop and deploy this technology. While it highlights China's aerospace aspirations, questions remain

about its proper functionality, especially given Beijing's prior struggles with engine technology.

China Teases Sixth-Generation Space Fighter, But Is It Real?

The 15th China International Aviation and Aerospace Exhibition kicked off on Tuesday outside the city of Zhuhai in the Guangdong province, marking the 75th anniversary of the founding of the People's Liberation Army Air Force (PLAAF). Since its beginning in 1996, the expo has highlighted the latest developments from China's aerospace industry.

Also known as the Zhuhai Airshow or Airshow China, the biennial event is now the largest aviation trade expo in the People's Republic of China, and there has been speculation that the star of [this year's show](#) would be the Shenyang J-35A, the carrier-based variant of the [Shenyang FC-31](#).

The Chinese military even teased the appearance of the fifth-generation fighter with posts [on social media](#), including photos of the demo aircraft featuring the number "75" on its tail section to honor the PLAAF's anniversary.

Though the J-35A will remain very much in the spotlight, another aircraft was especially noteworthy at this year's aerospace exhibition – the previously unrevealed "White Emperor."

NGAD© Provided by National Interest

The South China Morning Post reported that a life-size mockup of the next-generation fighter was on display, quickly catching attendees' attention.

"The Baidi, or White Emperor, is a project from the state-owned aerospace and defence conglomerate AVIC to develop what state media has described as an 'integrated space-air fighter,'" [the Post reported](#), citing Voice of China, an arm of state broadcaster CCTV. "The design concept includes the ability to fly at supersonic speeds and break through the Earth's atmosphere to operate in space."

The Sixth-Gen Space Plane

The White Emperor is reportedly being developed as part of China's "Nantianmen Project," a research and education initiative dedicated to future technology.

Though details remain sparse, the aircraft is noted for having large internal missile bases that could allow it to carry heavy ordnance while maintaining stealth capabilities. The number "6" was on its tail section – a cheeky attempt to drive home this is a "sixth-generation" fighter.

Images shared [on social media](#) provided a few details, but some quickly questioned whether its canards would impact its stealth, and others suggested it was simply a full-size version of the futuristic fighters seen in the popular *Ace Combat* video game series.

6th Generation Fighter© Provided by National Interest

Bulgarian Military offered [a detailed overview](#) based on what we can see – including "an advanced, broad landing gear structure that appears robust compared to standard configurations, hinting at a capability for takeoffs and landings on a variety of surfaces, even less-than-ideal runways. This feature is rare for stealth aircraft, which generally operate from specific airstrips."

The report added the "heavy-duty landing gear implies that the White Emperor B may handle heavier payloads and survive more intense landing maneuvers."

Of course, it is a mock-up and almost certainly not airworthy. China has rarely revealed so publicly its future aircraft – which is why we shouldn't expect to see its Xi'an H-20 stealth strategic bomber at this year's airshow. So we may not want to read too much into the landing gear, or even the "asymmetrical patterns" on the fuselage.

The report concluded, "The emergence of the White Emperor B signals not just a technical achievement in stealth and fighter design but a bold new chapter in China's aerospace ambitions, one that includes a clear aspiration to dominate not only the skies but the space beyond."

Or it could be an attempt at Chinese misdirection.

We know Beijing keeps its cards close to the chest, but more importantly, we also know that it has struggled with the engines with its Chengdu [J-20 Mighty Dragon](#), so it seems difficult to believe that the PLAAF has made a "great leap forward" from barely being able to deliver a fifth-generation fighter to suddenly producing a space plane that can somehow do it all. And then showing it to the world?

We should believe that the Nantianmen Project is working on a sixth-gen fighter, but it would seem unlikely that it would reveal such details so early in the program.



China reveals reusable cargo shuttle design for Tiangong space station

China has unveiled the design of a new reusable shuttle to take cargo to and from the country's space station.

The Haolong space shuttle is being developed by the Chengdu Aircraft Design and Research Institute under the state-owned Aviation Industry Corporation of China (AVIC). It is one of [two winning projects](#) stemming from a call for proposals from China's human spaceflight agency, CMSA, to develop low-cost cargo spacecraft.

China currently uses its robotic Tianzhou spacecraft to send cargo to the [Tiangong space station](#). But, taking a leaf out of NASA's book to [encourage commercial resupply options](#) for the International Space Station, CMSA wanted new, low-cost ideas that can also return experiments and other cargo to Earth, unlike the Tianzhou, which burns up on reentry.



A still from an animation detailing the design of China's planned Haolong cargo shuttle. (Image credit: CCTV+)

Haolong will launch atop of a rocket and land horizontally on Earth on a runway. The space shuttle measures 32.8 feet (10 meters) long and 26.2 feet (8 m) wide, and weighs less than half of the [Tianzhou](#) capsule, which has a mass of up to 31,000 pounds (14,000 kilograms). The winged spacecraft is now in the engineering flight verification phase, meaning its design and systems are under review before being built.

The shuttle's engineers are already hailing the design. "The Haolong space cargo shuttle is a winged aircraft with an aerodynamic design featuring a large wingspan and a high lift-to-drag ratio," Fang Yuanpeng, chief designer of Haolong, told China Central Television (CCTV). "With a blunt-nosed fuselage and large, swept-back delta wings, it combines the characteristics of both spacecraft and aircraft, allowing it to be launched into orbit by a rocket and land on an airport runway like a plane," he added.

Haolong will dock with Tiangong, allowing astronauts to enter and exit to collect or stow cargo. After completing the cargo transport mission, Haolong will

separate from the space station, autonomously deorbit and reenter the atmosphere, and land horizontally on the designated airport runway.

"After inspection, maintenance and repair, it will be able to perform cargo transport missions again," said Fang.

It is not the only reusable cargo shuttle in development. Private American firm Sierra Space is developing the long-delayed [Dream Chaser](#) to send cargo and astronauts to low Earth orbit.

China aims to operate Tiangong for at least a decade, and plans to expand the three-module, T-shaped orbital outpost to six modules. Haolong could play a part in keeping the space station supplied with food, experiments and other cargo.

F-35 Beast Mode: How America's Stealth Jet Becomes a Bomb Truck



F-35 Beast Mode

Summary and What You Need to Know: The F-35, known for its stealth and precision, can switch to "Beast Mode," vastly increasing its firepower. In stealth mode, the F-35 carries just 5,700 pounds of internal weapons to minimize its radar cross-section.



F-35© Provided by National Interest

- However, once air superiority is secured, the jet can deploy external hardpoints, boosting its payload to 22,000 pounds.
- This transformation allows the F-35 to carry up to 14 AMRAAMs and six 2,000-pound JDAM bombs, though at the cost of halving its operational range.
- Beast Mode ensures the F-35's versatility, allowing it to dominate in both initial stealth operations and prolonged, high-intensity conflicts.

F-35 Beast Mode: Transforming Stealth into Sheer Firepower

The [F-35](#) is typically perceived as a graceful and refined fighter, created with advanced features emphasizing concealment and surgical precision. The common perception is grounded in truth; indeed, the F-35 is a fifth-generation stealth

fighter, built to house software that enhances network connectivity and data sharing. But the common perception discredits the F-35 for its versatility – and for its ability to “roll up its sleeves.”

Remember, the F-35 is a multi-role fighter, and when prompted, can be reconfigured as a straightforward, knuckle-dragging, bomb-carrier. The reconfiguration is known as [“Beast Mode.”](#)

All Out Flight

Designed with stealth technology, the F-35 is adept at entering contested airspace, avoiding detection, and engaging enemy targets – all before air superiority is established. Really, the F-35 is designed expressly to initially establish air superiority. And because the F-35 is designed to be stealthy, concessions were made with respect to weapons payloads. To enhance its stealth characteristics, the F-35 uses an internal weapons bay, rather than external hard points that drastically increase an aircraft’s radar cross-section. While the internal weapons bay makes for a stealthier airframe, the storage space, inside the fuselage, is limited.



F-35© Provided by National Interest

F-35 Stealth or Carry: Enter Beast Mode

In stealth mode, when the F-35 carries weapons internally, the jet can handle just 5,700 pounds of ordinance. That breaks down to either four [AIM 120 AMRAAM](#) missiles (for air-to-air missions), or alternatively – for hybrid missions – two AMRAAMs paired with two GBU-31 JDAM bombs. That's not very much firepower – but the concession is worthwhile to gain stealth benefits.

However, once air superiority is established, once an enemy loses its anti-air systems such as air defense missiles and guns, sensors, interceptor aircraft, stealth mode becomes less relevant. And when stealth loses its relevance, the F-35 can enter "Beast Mode," and use its external hard points to maximize its firepower.

In Beast Mode, the F-35 can handle four times more ordinance than when operating in stealth mode. Using the external hardpoints plus the internal weapons bay, the F-35 can carry 22,000 pounds of ordinance. That breaks down to 14 AMRAAMs and two AIM-3x Sidewinder missiles for air-to-air missiles.

Or, for hybrid missions, the jet can be outfitted with two AMRAAMs, two Sidewinders, and six JDAM 2,000-pound bombs. Indeed, the boost in firepower is significant – although, in Beast Mode, the F-35's operational range is cut in half – to just 1,400 kilometers.

Something may feel counterintuitive about using the F-35, a [fifth-generation jet](#)/supercomputer, as a simple bomb truck – a role that clunkier, Cold War-era aircraft, like the [F-16](#) or [B-52](#), are entirely equipped to handle. Yet, when you consider that the F-35 program cost taxpayers 1.7 trillion dollars, the notion of using the jet *just* to secure air superiority in the opening salvo of a conflict becomes offensive.



F-35© Provided by National Interest

If you're going to spend that type of money on an airframe, you'd better milk it for all it's worth – a sentiment that the Beast Mode configuration embodies. And for the U.S., which has a tendency to invade [countries](#) with rudimentary air defense systems – and then stick around for multi-decade [occupations](#) – the F-35 needs to be able to do more than just sneak around and wipe out air defense systems in the first few days of conflict.

NGAD: Can the Air Force Afford a \$300,000,000 Fighter Jet?



NGAD© Provided by National Interest

What You Need to Know: The U.S. Air Force's sixth-generation NGAD fighter program has been paused due to its high unit cost of \$300 million and concerns about outdated design requirements.



NGAD© Provided by National Interest

- Air Force Secretary Frank Kendall emphasized re-evaluating NGAD's concept amid evolving threats and budgetary constraints, particularly with the emergence of Collaborative Combat Aircraft (CCA) drones.

- CCAs are expected to reduce costs while enhancing mission flexibility. Meanwhile, the Air Force is slowing down the F-22 Raptor's retirement to avoid capability gaps.

- With China advancing its own next-gen stealth bomber, the need for advanced U.S. air superiority technology remains urgent in the face of rising tensions.

Can the U.S. Afford a \$300M Fighter? NGAD Faces Major Hurdles

The U.S. Air Force's sixth-generation fighter program has taken a pause. While this "family of systems" is designed to maintain air superiority against rising threats, budgetary constraints have impeded its eventual entry into service. The unit price for the Next-Generation Air Dominance (NGAD) program is [estimated](#) at \$300 million.

This exorbitant cost, notably three times higher than the infamous F-35 Joint Strike Fighter, may serve as the new fighter's death sentence. Air Force Secretary Frank Kendall explained that the program was paused this summer so that the service could take, "a very hard look at whether (the USAF) has got the right design concept or not."

What's holding NGAD back?

When NGAD was first conceptualized over a decade ago, its [planned capabilities](#) were unmatched. However, now that the next-generation program is already several years old, its initial design requirements may be outdated. Specifically, Kendall noted that due to "threat changes; because of financial constraints; because of the development of technology, including the introduction of autonomous Collaborative Combat Aircraft (CCAs)," he said, it would be imprudent to commit to a single design before reconsidering all available options."

Derived from DARPA's Air Dominance study, the [NGAD fighter](#) will feature a variety of advanced technologies, with a particular focus on stealth, propulsion, and sophisticated weapons. Perhaps the most significant component of the next-gen program will be the incorporation of highly autonomous unmanned aerial vehicles (UAVs) dubbed collaborative combat aircraft. These [CCAs](#) will be designed to carry out surveillance, test enemy air defenses, and extend command and control under human direction while serving in their "loyal wingmen" capacity.

Is the NGAD still worth it despite the price?

Theoretically, the inclusion of these [CCAs](#) will bring the overall budget of NGAD down significantly. These small, relatively easy-to-construct, and cheaper drones could even be intentionally sacrificed amidst a kinetic conflict, according to Kendall. Even considering the cost-friendly nature of the CCAs, the \$300 million price tag associated with the overall program remains an obstacle to overcome for the Air Force.



NGAD© Provided by National Interest

While the [NGAD's introduction](#) is up in the air, the Air Force no longer appears to be fast-tracking the retirement of its remaining F-22 Raptor fleet. As the world's first-ever fifth-generation to take to the skies, the Raptor still features capabilities unmatched by newer platforms like the F-35 Joint Strike Fighter. To [prevent](#) a cap in capability, the F-22 should not be relegated to retirement completely until its replacement is secured.

The U.S. isn't the only nation working to introduce next-generation technology. China is working to rapidly develop its own sixth-gen H-20 stealth bomber. Rising tensions between Beijing and Washington could culminate in an all-out war shortly. If such a conflict unfolds, the U.S. will need all the sixth-generation technology possible.

Russia's Su-57E Felon Is Making History: Flying in China



Su-57 Felon Fighter Russian Ministry of Defense Photo© Provided by National Interest

What You Need to Know: Russia's Su-57E fifth-generation stealth fighter debuted at the China International Aviation and Aerospace Exhibition, aiming to impress attendees and attract international buyers.



Su-57© Provided by National Interest

- Despite grandiose claims from Russian officials about the Su-57's combat-readiness and "exceptional performance," the jet faced considerable skepticism, particularly from Chinese observers who noted visible flaws in design and stealth.
- Aviation analysts have questioned its actual combat utility, citing that the Su-57 has notably avoided deployment in high-risk zones like Ukraine, likely to avoid potential downing and further criticism. While it may captivate airshow audiences, the Su-57's reputation doesn't align with the hype from Russian officials.

Russia's Su-57E Takes Flight in China

Rostec, the Russian state-owned military-industrial conglomerate, has put high hopes on the showing of its [Sukhoi Su-57](#) (NATO reporting name Felon) at this week's 15th China International Aviation and Aerospace Exhibition, which kicked off on Tuesday outside the city of Zhuhai in the Guangdong province.

Russian state media outlet [Tass reported](#) that the Su-57E, the export model of the fifth-generation stealth fighter, "soared into the skies on the first day" of the international aerospace trade expo, and attracted "significant interest from airshow attendees." The aircraft had Hero of Russia and noted test pilot Sergey Bogdan at the controls while it took part in aerobatic maneuvers.

Tass also cited Rostec CEO Sergey Chemezov's claims that "the Su-57 is the only fifth-generation aircraft globally that has demonstrated its exceptional performance characteristics in all combat scenarios. The fighter also boasts impressive survivability due to its low radar signature and advanced onboard defensive systems."



Su-57© Provided by National Interest

Rosoboronexport CEO Alexander Mikheyev also highlighted the Su-57's [use in combat](#).

"Su-57E fully meets all requirements [of] fifth-generation aircraft. Its major competitive advantage is the real combat engagement experience. The Russian Defense Ministry said it excellently performed in combat. The jet is distinguished

by powerful weapons with the latest missiles, as well as a high survivability due to low signature and modern onboard defense," Mikheyev said on the sidelines of the Chinese airshow.

What Wasn't Said – But We'll Say It on the Su-57E Felon

Though the purpose of presenting the Su-57 at Airshow China was to boost awareness of the multirole fighter, most aviation analysts and watchers would be forgiven for smirking (or outright laughing) at the statements made by Chemezov and Mikheyev respectively.

The aircraft received [very public mockery](#) last week when the prototype Su-57 arrived in advance of the airshow. Criticism from commentators quickly made the rounds [on social media](#), yet, weren't from U.S. aviation buffs that might have a bias against the Russian warbird. Instead, they were from those in China who highlighted every shortcoming they could find.

At issue was that the aircraft was photographed in ways that Russia's adversaries might have once only dreamt of, and soon armchair pundits and aviation buffs weighed on every shortcoming they could spot. However, the photos of the prototype only allowed all its flaws to be seen by the world.

Lord Protector Oliver Cromwell [may have uttered](#), "Paint me as I am, warts and all," when he sat for his formal portrait – but aviation buffs want to see the "pinup girl" version that is caked in makeup and airbrushed to look as fabulous as possible.



Su-57© Provided by National Interest

Moreover, it wasn't just that the Su-57 didn't look particularly "stealthy" when it arrived in China; it was the fact that the aircraft hadn't really lived up to all the hype that Chemezov and Mikheyev offered. Their claims of combat effectiveness are truly laughable given that the Kremlin hasn't deployed the Su-57 over the skies of Ukraine, and likely for good reason.

Moscow would not want the bad publicity should one be shot down, and therefore its impressive survivability isn't from its low radar signature but rather because the aircraft hasn't been used anywhere within range of Ukrainian air-defense systems.

In other words, it might remain an aircraft that does impress at an airshow, but that is unlikely to result in foreign buyers lining up, no matter how much the Russian comedy duo would like it to.

Chinese H-20 bomber: Emerging stealth threat or overhyped?



One of the visualizations showing the possible appearance of the H-20 bomber.© air data news

New visualizations of the Chinese stealth bomber Xi'an H-20 have surfaced on Chinese social media. The aircraft, under development since 2016, is reportedly being designed in a flying wing configuration, with a

design that closely resembles the American strategic bombers B-2 Spirit and B-21 Raider.

The 15th edition of Airshow China 2024, scheduled from November 12 to 17, promises surprises. The hosts, along with guests, are determined to make it noteworthy. During the event, Russia will present its premier fighter, the fifth-generation Su-57, garners more sarcasm than admiration. China, meanwhile, is announcing the official debut of Beijing's second stealth fighter, the J-35A. Photos of the enigmatic J-20 fighter cockpit, expected to appear at the show, have also appeared online.

China is working on a new strategic bomber

Aviation experts had anticipated that Airshow China 2024 might be an opportune moment for the debut of the Chinese strategic bomber Xi'an H-20. However, according to National Interest, this is more likely to occur during Airshow China 2026. The delay will allow Beijing to enhance the aircraft, potentially challenging American strategic bombers like the B-2 Spirit and its successor, the B-21 Raider bombers.

Photos available on Chinese social media likely do not capture the final concept of the H-20 but do highlight the direction the Chinese have taken in the aircraft's development. The plane is being designed in a flying wing configuration. This tailless design, lacking a distinct fuselage or empennage, may help reduce fuel consumption and hinder detection by advanced radar and missile systems, increasing its effectiveness during missions over contested or enemy territories.

According to Army Recognition, "it is expected that the H-20 will be a highly advanced asset in China's strategic arsenal, designed for extended range, large payloads, and increased survivability in contested environments." The exact specifications of the aircraft remain unknown, but claims suggest its range may reach up to 5,280 miles, with the ability to carry both conventional and nuclear weapons. Its payload capacity is anticipated to be at least 22,000 pounds. Notably, unlike Beijing's currently used Xi'an H-6 bombers, which are licensed versions of the Soviet Tupolev Tu-16, the H-20 is an indigenous project.

Thus, the H-20 could become a crucial component of China's nuclear triad and deterrence strategy. However, analysts from National Interest indicate that American officials are not highly concerned about the progress of the H-20 project. The Pentagon is reportedly skeptical of its capabilities. Americans, including Gen. Kenneth Wilsbach, believe that the H-20 lags far behind the capabilities of future U.S. bombers, like the B-21 Raider, and is also trailing the B-2 Spirit bombers.

Nonetheless, the overall pace of China's military expansion is concerning. Beijing allocates significant resources to the development of its weapons systems, including fighters and the aforementioned bombers. It is also expanding its nuclear arsenal, as highlighted in a recent report by the Defense Intelligence Agency, the American military intelligence agency within the Pentagon. The document notes that in 2020, Beijing had approximately 200 operational nuclear warheads, currently possesses about 500, and their number could exceed a thousand by 2030.

The US Navy has made a significant step towards drones in carrier air wings



The MQ-25 Stingray unmanned carrier jet, soon to go into service with the US Navy in the air-to-air refuelling role - Boeing

A sophisticated drone winging over California while data-linked with a control station far away in Maryland has just laid the foundation for the US Navy's future carrier air wings. It's about time.

Navy leaders have said they want to transform the US fleet's nine carrier air wings, which embark on [the fleet's 11 nuclear-powered supercarriers](#). Today there

are no drones among the 60 or 70 aircraft – fighters, electronic-warfare planes, radar planes and helicopters – that normally populate a carrier air wing.

The goal is for pilotless planes to eventually make up nearly two-thirds of each wing.

The imperative is obvious. In general, an unmanned plane can fly farther than a manned plane can, and can fight without exposing a human pilot to danger. Drones might be the best way to address the extreme distances that would define any [future war in the Pacific region](#).

Despite this, the tradition-bound Navy has moved slowly to integrate drones with its air wings. The US Air Force has been operating large, armed, fixed-wing drones since the early 2000s: propeller-driven Predators and Reapers and, soon, jet-propelled [Collaborative Combat Aircraft "loyal wingmen"](#).

By contrast, the Navy *still* doesn't have an armed, fixed-wing drone – despite experiments dating back 20 years. [Tests with the X-47B "Salty Dog" prototype](#) proved that an unmanned jet with a fully stealthy design – that is, one without rudders – can land on a carrier, but the USN has resisted combatant drones. Instead the fleet's first carrier drone, the MQ-25 Stingray, [will be employed strictly as an aerial tanker](#) when it first goes to sea in the coming few years. Its maker Boeing has stated that it could easily be equipped for other missions, however, and the fact that it is unmanned and stealthy might easily make it the real-world first choice for missions into dangerous airspace.



An X-47B demonstrator launches from a catapult aboard the aircraft carrier USS George HW Bush in 2013. The X-47B project proved that unmanned aircraft with fully stealthy shapes could operate from US carriers - Alan Radecki/US Navy/Northrop Grumman

Wider changes should come in time, and the California-to-Maryland test has made them possible.

On November 5, California drone-maker General Atomics – the builder of the Predator, the Reaper and one of the initial loyal wingman models – launched one of its MQ-20 Avengers for a critical test flight. The Avenger is essentially a stealthier, jet-propelled version of the older turboprop Reaper, currently the mainstay of the Air Force's armed drone force.

Working with plane-maker Lockheed Martin and the Navy, General Atomics connected the MQ-20 via satellite to an MD-5 drone control station at a naval air station in Maryland, more than 2,000 miles away. "The team not only executed airborne commands, but did so in a safe, controlled environment," General Atomics president David Alexander [said](#).

The MD-5 is basically an aircraft cockpit without the actual aircraft. A drone operator sitting in an MD-5 – which includes a seat, a control stick and various screens – can see what their drone sees and control it from anywhere in the world, as long as the radio link to the satellite and the drone is secure.

The great thing about the MD-5 is that it will connect to a wide array of drone types, not just the MQ-20. The Navy is installing MD-5 control stations aboard its supercarriers in order to support the MQ-25 drone tankers initially – but the stations are also compatible with any future naval versions of the Air Force’s speedy loyal wingman drones. The Avenger used in the recent test, in fact, [is a candidate for that role](#).

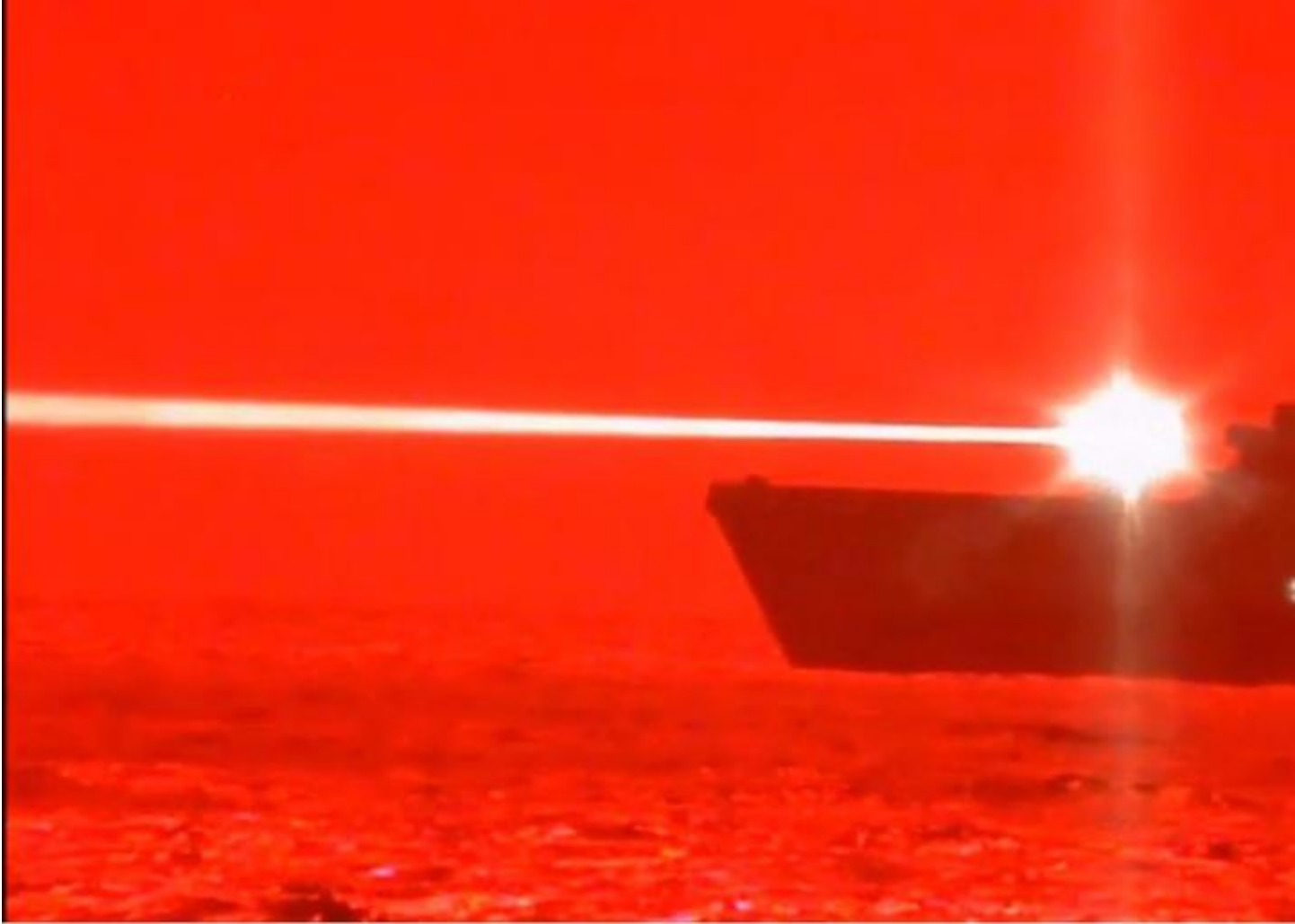
With the MD-5s deep inside their hulls, the carriers will be ready for those majority-drone air wings the Navy is hoping for. It might take a while, of course: the fleet is already expecting its next main carrier fighter, the F/A-XX, to be a manned plane. The Air Force is now potentially going cold on its similar land-based fighter project, the Next Generation Air Dominance jet, and [might even replace that with extra B-21 Raider stealth bombers](#), armed with air-to-air weapons and commanding squadrons of accompanying drones. The Navy’s F/A-XX [might wind up being America’s only sixth-generation manned fighter](#).

Nonetheless the F/A-XX is being designed from the wheels up to fly and fight alongside armed drones. By the time the new manned fighter is ready, potentially some time in the 2030s, a naval version of the Air Force’s loyal wingman should be ready, too.

There will probably be a transitional carrier air wing design, one that has drones but isn’t *mostly* drones, for years or even decades before the majority-drone air wing is possible. The drone crews for this interim wing will sit in MD-5 control stations. Thanks to that recent overland test, we can be confident the stations will work as intended.

Now that it has the control stations, the Navy needs more drones to go with them.

Combat lasers: From sci-fi to real-world battlefield tech



Tests of American laser weapons; illustrative photo© US Navy

On a daily basis, we typically associate lasers with pointers, industrial laser "blades," or medical instruments. When we hear about laser weapons, our minds primarily turn to weapons from the "Star Wars" universe or other science fiction productions. However, this does not mean that outside the "distant galaxy," combat laser systems are non-existent; they are slowly finding their place in the modern arsenal.

The laser itself, an acronym for Light Amplification by Stimulated Emission of Radiation, is a subset of so-called directed energy weapons. It is, in a sense, a type of lamp that emits electromagnetic radiation in various ranges through the phenomenon of stimulated emission. Laser radiation is coherent, and the beam is characterized by low divergence.

Laser for the army

Lasers have been used militarily for decades—initially, they were mainly employed as key elements in weapon guidance systems. They continue to serve this function today, as seen in the Polish Pirat/APR-120/155 system. **Additionally, laser rangefinders are standard components of fire control systems.**

There are also lasers designed to injure rather than kill targets. **Their primary role is to permanently blind opponents.** However, such lasers are banned as inhumane under Protocol IV of the Convention on Certain Conventional Weapons from 1980. A slight exception exists for lasers that cause temporary blindness, which law enforcement may use. These lasers typically have a power output well below one kilowatt (kW).

Decidedly more powerful are true combat systems, which remain largely in advanced experimental stages but show promising results. Currently, tested combat lasers generally have power outputs ranging from tens of kW (usually 20-60 kW), with some significantly more powerful systems reaching hundreds of kW. The main goal of developing such "cannons" is to provide the future user with a cost-effective defensive system.

Lasers are often considered potential successors to small-caliber cannons and large-caliber machine guns for defensive applications. However, this requires delivering energy to the target at a rate of 4 kW per square inch of its surface, enabling the laser to burn through the object, damaging or even destroying it.

As for the targets themselves, they generally include all sorts of drones, missile and cruise missile targets, small boats (including unmanned "surface torpedoes"), and similar objects. The proliferation of inexpensive, improvised combat drones

(simple FPV drones), despite their low individual effectiveness, is driving the development of laser air-defense systems due to cost-effectiveness.

The cheapest, albeit least effective, suicide drone costs around \$1,000. In comparison, the cost of a single 1.2-inch programmable shell is similar, while that of a rocket projectile is many times higher. This has created a need for a more affordable alternative, and it seems that **lasers might be the answer to this problem**. Various estimates suggest that a single "shot" costs a few to a dozen dollars, generally offering adequate performance in range and accuracy.

Research on laser weapons

Research on combat lasers is being conducted in many countries, often via multiple avenues. Leading the efforts is the USA, which developed the YAL-1 system—a type of oxygen-iodine laser cannon mounted on the nose of a Boeing 747-400F aircraft. The first trials of a similar system were conducted in the 1980s, targeting ballistic missiles. However, it never entered mass production, and the program was abandoned several years ago, although the concept persisted for some time.

A similar project, this time as an anti-satellite weapon, was attempted by Russia under the Sokół-Echelon program. **Smaller lasers, according to some concepts, could form a defensive system for sixth-generation multi-role aircraft (e.g., American NGAD), serving as weapons to destroy anti-aircraft and air-to-air missiles.**

In naval fleets, there is also a trend towards deploying laser weapons. The US Navy tested a laser "cannon" aboard the USS Ponce and later the USS Portland, which successfully shot down an RQ-21 Blackjack drone during tests using the SSL-TM laser. Europe is not far behind. In 2022, the German frigate Sachsen shot down multiple drones using the LWD device developed by MBDA Deutschland and Rheinmetall Waffe Munition.

LWD performed over 100 test launches from the Sachsen frigate, proving that the laser can effectively combat targets in a maritime environment. Meanwhile, the British are intensively testing the DragonFire system, which has a power output of

up to 50 kW and is intended for deployment on various Royal Navy surface ships (including Type 32 frigates). The Chinese are also working on a similar system.

Attempts to develop land-based lasers

Developing an effective land-based laser has proven to be most challenging, as the Americans have recently realized. During May tests of the DE M-SHORAD laser air-defense system on a Stryker transporter chassis, it was found that the 50 kW system did not meet expectations in terms of effectiveness at longer distances (up to 6 miles) and was unreliable during on-the-move engagements.

Nevertheless, the US Army is funding several laser weapon programs with power outputs ranging from 10-300 kW for various applications: portable, stationary, and mobile. The most interesting land-based laser system remains the Soviet 1K17 Shatir on the 2S19 howitzer chassis, which was intended to destroy the optoelectronic equipment of enemy vehicles. Its effectiveness is not well-documented, but it was expensive to produce—one unit required about 66 pounds of synthetic rubies.

Beijing has advanced further, producing the fiber laser Silent Hunter, which is effective up to 0.6 miles and was used in combat by Saudi Arabia. It is possible that the Israeli fiber-optic Iron Beam was also used in combat during clashes in the Gaza Strip. Another interesting solution is the American Zeus-HLONS, a lightweight system with a power output of about 10 kW, mounted on the roof of an HMMWV vehicle. It serves to destroy mines and improvised explosive devices, with a range of up to 1,000 feet and the capability to fire up to 2,000 times a day.

Limitations

The lasers mentioned are just selected examples of contemporary (and not only) laser weapons. They differ by country of origin, manufacturer, operational mode, and intended use, but they all share certain limitations. The laser beam is susceptible to "blooming" (beam spread and thus reduced power impacting the

target), especially when the air contains impurities such as smog, dust, or dense fog. Consequently, smoke grenade launchers are used on combat vehicles to hinder laser use (usually limited to rangefinders).

Furthermore, the development of laser weapons as a defensive "shield" against missiles and drones ("sword") has led to the creation of a "counter-shield": work on coatings for missiles, drones, or aircraft that can limit the effectiveness of such systems. Lasers, especially higher-powered ones, require significant electrical energy, which must be produced, stored, and then transferred to the "cannon." This entire process generates cooling challenges. Despite these problems, the economic considerations point towards the continued development of laser combat systems. However, it remains uncertain when they will be fully incorporated into military use.

List of VTOL aircraft

This is a list of fixed-wing aircraft capable of [vertical take-off and landing](#) arranged under manufacturer. The list excludes [helicopters](#), including [compound helicopters](#) and [gyrocopters](#), because they are assumed to have this capability.

For more detail on subtypes of VTOL, see [List of tiltrotor aircraft](#).

This is a [dynamic list](#) and may never be able to satisfy particular standards for completeness. You can help by [adding missing items](#) with [reliable sources](#).

A

[\[edit\]](#)

- [AeroVironment SkyTote](#) (tailsitter)
- [AgustaWestland AW609](#) (tiltrotor)
- [Armstrong Whitworth AW.171](#) (ducted fan)
- [Avro Canada VZ-9 Avrocar](#) (ducted fan)

B

[\[edit\]](#)

- [BAE Harrier II](#) (vectored thrust)
- [BAE Sea Harrier](#) (vectored thrust)
- [Bell 65 ATV](#) ([Tiltjet](#))
- [Bell/Agusta BA609](#) (tiltrotor), presently known as [AgustaWestland AW609](#)
- [Bell Boeing Quad TiltRotor](#) (proposal)
- [Bell Boeing V-22 Osprey](#) ([tiltrotor](#))
- [Bell Eagle Eye](#) (tiltrotor UAV)
- [Bell V-280 Valor](#) ([tiltrotor](#))
- [Bell X-14](#) (vectored thrust)
- [Bell X-22](#) ([ducted fan](#))
- [Bell XV-3](#) (first tiltrotor)
- [Bell XV-15](#) (tiltrotor)
- [Bensen B-10](#) (ducted fan)
- [Boeing/McDonnell Douglas AV-8 Harrier](#) (vectored thrust)
- [Boeing-Vertol VZ-2](#) ([tiltwing](#))
- [Boeing X-32B](#) (vectored thrust)
- [Boeing X-50](#) (stoppable-rotor gyrodyne UAV - failed to achieve forward flight)
- [Boulton Paul P.137](#) VTOL research aircraft
- [Boulton Paul P.142](#) VTOL research aircraft
- [British Aerospace P.125](#)

C

[\[edit\]](#)

- [Canadair CL-84 Dynavert](#) (tiltwing)
- [Carlson-Lynch Vertipactor](#)
- [Chappedelaine LeGyraptere](#)
- [Chrysler VZ-6](#) (ducted fan)
- [Colugo Systems-ARcopter](#) (tilt-quadcopter)
- [Convair XFY-1](#) Pogo (tailsitter)
- [Curtiss-Wright VZ-7](#) (flying jeep)
- [Curtiss-Wright X-19](#) (tiltrotor)

D

[\[edit\]](#)



U.S. Army Doak 16/VZ-4DA

- [Dassault Balzac V](#) (separate lift and thrust engines)
- [Dassault Mirage IIIV](#) (separate lift and thrust engines)
- [Doak 16/VZ-4DA](#) (ducted fans)
- [Dornier Do 31](#) (thrust vectoring and lift jets)
- [DuPont Aerospace DP-1](#) (vectored thrust)

E

[\[edit\]](#)

- [EWR VJ 101](#) (tiltjets and lift jets)

F

[\[edit\]](#)

- [Fairey Gyrodyne](#) (gyrodyne)
- [Fairey Jet Gyrodyne](#) (gyrodyne)
- [Fairey Rotodyne](#) (gyrodyne)
- [FLUTR model 1](#) (quadcopter gimbal duct tilt rotor swing wing)
- [Focke-Wulf Triebflügel](#) (tailsitter, not built)
- [Fokker/Republic D-24 Alliance](#) (mockup only)

G

[\[edit\]](#)

- [Garrett STAMP](#) (vectored thrust)
- Grumman Future Attack Air Vehicle
- Grumman Model 623
- [Grumman Nutcracker](#) (tilt-fuselage^[1])

H

[\[edit\]](#)

- [Hawker P.1127](#) (vectored thrust)
- [Hawker Siddeley Harrier](#) (vectored thrust)
- [Hawker Siddeley Kestrel](#) (vectored thrust)
- Hawker-Siddeley HS.133
- Hawker-Siddeley HS.138 (ducted fans)^[2]
- Hawker-Siddeley HS.145
- [Hawker Siddeley P.1017](#) (cancelled supersonic vectored thrust)
- [Hawker Siddeley P.1154](#) (cancelled supersonic vectored thrust)
- Hawker Siddeley P.1184-16 Dash 18
- Hawker Siddeley P.1217
- [Heinkel Lerche](#) (coleopter; not built)
- [Hiller VZ-1 Pawnee](#) (ducted fan)
- [Hiller X-18](#) ([tiltwing](#))

L

[\[edit\]](#)

- [Lockheed Martin F-35B Lightning II](#) ([Thrust Vectoring](#))
- [Lockheed XFV-1](#) "Salmon" ([tailsitter](#))
- [Lockheed XV-4 Hummingbird](#) (vectored thrust with entrained air)
- [LTV XC-142](#) (tiltwing)
- [Lunar Landing Research Vehicle](#) (gimbaled vertically mounted jet)

M

[\[edit\]](#)

- [Martin Jetpack](#) (portable ducted fans)
- [McDonnell Douglas AV-8B Harrier II](#) (Tilted output vector and RR vectors)
- [Messerschmitt P 1227](#) (VJ 101B)^[3]
- [Moller Skycar](#) (vectoring ducted fans)

N

[\[edit\]](#)

- [NASA Puffin](#) ([tailsitter](#) proposal)^[4]
- [Northrop Grumman Tern](#)
- [Northrop MRF-54E](#)

O

[\[edit\]](#)

- [Opener BlackFly](#)

P

[\[edit\]](#)

- [Piasecki VZ-8 Airgeep](#) (ducted fans)
- [Porter Gyropachute](#) (ducted fan)

R

[\[edit\]](#)

- [Republic AP-100](#) (ducted fans)
- [Rockwell XFV-12](#) (wing lift augmentation, failed to fly)
- [Rolls-Royce Thrust Measuring Rig](#) (vertically mounted jet)
- [Rotary Rocket Roton](#) (rotating annular aerospike rotor)
- [Ryan X-13 Vertijet](#) ([tailsitter](#))
- [Ryan XV-5 Vertifan](#) (liftfans)

S

[\[edit\]](#)

- [Short SC.1](#) (liftjet and vectored thrust)
- [Sikorsky Cypher](#) (ducted fan)
- [Sikorsky X-Wing](#) (stoppable rotor; did not fly in this configuration)
- [SNECMA Coléoptère](#) (tailsitter)
- [SoloTrek XFV](#) (ducted fans)
- [Springtail Exoskeleton Flying Vehicle](#) (ducted fans)

T

[\[edit\]](#)

- [Trek Aerospace Dragonfly](#) (ducted fans)

V

[\[edit\]](#)

- [VFW SG 1262 Schwebegestell](#)
- [VFW VAK 191B](#) (vectored thrust plus vertical lift)
- [Volocopter VoloConnect](#)

W

[\[edit\]](#)

- [Williams WASP^{\[5\]}](#)
- [Williams X-Jet](#) (flying platform)

Y

[\[edit\]](#)

- [Yakovlev Yak-141](#) (liftjet and vectored thrust)
- [Yakovlev Yak-36](#) (vectored thrust)
- [Yakovlev Yak-38](#) (liftjet and vectored thrust)

Z

[\[edit\]](#)

- [Zhuchenko Vertoplan](#) (tiltwing)

See also

[\[edit\]](#)

- [Coleopter](#)
- [Compound helicopter](#)
- [Gyroplane](#)
- [Tiltjet](#)
- [Tiltrotor](#)
- [Tail-sitter](#)
- [Tiltwing](#)

References

[\[edit\]](#)

1. [^] *"Popular Science"*. Retrieved 2013-09-25.
2. [^] Hatfield Future Projects Newsletters No.24, April 1988
3. [^] <http://www.robertcmason.com/textdocs/GermanVSTOLFighters.pdf> ^[bare URL PDF]
4. [^] Choi, Charles Q. (2010-01-19). *"Electric Icarus: NASA Designs a One-Man Stealth Plane"*. *Scientific American*. Retrieved 2009-01-22.
5. [^] Flight 21 Feb 1974, p. 251

The YF-23 vs. F-22: A Stealth Fighter Showdown That Shaped Aviation History



The late 1980s would soon be defining an era for the United States Air Force in terms of a high-stakes game of military aviation. The U.S. initiated the Advanced Tactical Fighter (ATF) program: a competitive project that would ultimately define the future of air combat. Northrop and Lockheed Martin, two aerospace giants, went head-to-head with their respective designs, the YF-23 and the YF-22.



Northrop's YF-23, the marvel and super speed, was a radical departure from the traditional designs when it comes to fighters. Its powerful engines allowed supersonic speeds without the afterburners by going supersonic through extreme ease due to its supercruise at Mach 1.6.



In contrast, Lockheed Martin's YF-22 emphasized agility and high-G maneuverability.



Although the YF-23 outclassed its Lockheed Martin competitor in stealth and speed, what worked in the favor of the former eventually was that the latter was more agile and featured thrust vectoring.



Today, the YF-22 is known as the F-22 Raptor, becoming the world's very first operational fifth-generation fighter with its service entry by the US Air Force, further evolving into multirole use not only for air-to-air but also for air-to-ground duties.



Although it would not be selected, the YF-23 would leave its mark on the history of aviation.

Its design and technology would play a significant part in shaping the future stealth aircraft: F-35 and B-2 Spirit.



Each of the modern fighters holds some of the lessons learned from the development of the YF-23, Stealth, Speed, and Agility.



The F-22 Raptor persists in service as the spine of US air supremacy, intercepting threats and participating in combat operations worldwide.



The F-22 Raptor persists in service as the spine of US air supremacy, intercepting threats and participating in combat operations worldwide.

The legacy of the YF-23 lives on to remind us of innovation and the relentless pursuit of air dominance. Related images you may seem to be interested in:





Lockheed Martin's SR-72 Darkstar: The Hypersonic Successor to the Iconic SR-71 Blackbird



The legendary SR-71 Blackbird, as soon as it has its successor, may certainly redefine the way aerial reconnaissance and strike capabilities are to be perceived because it is given its unparalleled speed and altitude. Lockheed Martin's Skunk Works team is working on the SR-72 "Darkstar," a hypersonic aircraft that aims to reach Mach 6.0. This would be twice the capability of the predecessor.

The SR-71 was unveiled to the world over half a century ago and could reach an altitude of 85,000 feet and Mach 3.2.

Its retirement in the late 1990s meant it would never be challenged for this record, but the supposed SR-72 has promised much more.



Popularized by its appearance in the latest Top Gun movie, it promises to transcend feats that would never have been seen or imagined in this aircraft's lifetime.



Firm Lockheed Martin partnered with Aerojet Rocketdyne for the new engine for the SR-72; it would take advantage of technology from the now-canceled HTV-3X.



The turbine-based combined cycle (TBCC) engine that the SR-72 will be using is a dual-mode ramjet engine, which will enable take-off at conventional jet speeds and then zoom up to hypersonic speeds of potentially over Mach 6.0.



It has not been an easy ride to develop the SR-72. The latest reports show that in Q2 2024, the program overspent by an additional \$45 million, leaving it with a comprehensive loss since 2022 to \$335 million.

Still, hope for the SR-72 remains alive. Lockheed Martin will continue to be extended with the program as shrouded in secrecy, marching toward operational status, perhaps to meet future U.S. Air Force needs.

Hence, the SR-72 would be an ISR asset with strike capability; whereas the SR-71 aircraft could only be used for reconnaissance missions, the SR-72 aircraft would engage the target directly.



Based on this feature added to hypersonic missiles, it would be possible for a weapon system to breach any airspace and strike any point on a continent within sixty minutes.

It would be an entirely new kind of strategic advantage, said Lockheed Martin's program manager, as such a machine "penetrates denied airspace and strikes at nearly any location across a continent in less than an hour."



It's a capability no other weapon in the U.S. Air Force's inventory can especially with rising tensions between Washington and Beijing continuing unabated.

The SR-72 has been classified, but Lockheed Martin upped its advanced development programs unit by 75 percent and hired more than 2,300 new employees since early 2018.

That kind of investment means that the production will be of a new classified aircraft for use in operational service.

The SR-72 is taking shape as an aircraft that will revolutionize the air reconnaissance and strike capabilities, permitting the United States Air Force to achieve unprecedented speed and strategic advantage.

Photos: Blended wing body aircraft promises 50% fewer emissions, 30% less fuel use

The Horizon's blended wing design offers 40% more interior space and increased lift, challenging the standard airliner configuration.



The blended wing body Horizon.

[Natilus](#)

Aerospace startup Natilus is shaking up the aviation world with its Horizon Blended Wing Body (BWB) passenger/cargo aircraft.

This innovative [design](#) promises to carry up to 200 passengers on long-haul flights, like New York to London, while cutting emissions by 50% and reducing fuel consumption by 30%.

For decades, the standard [aircraft design](#) has been a combination of a cylindrical fuselage and [wings](#), whether jet or propeller-driven. While this design has been effective, it's not without its limitations. Issues like drag, space utilization, and overall efficiency remain concerns for engineers.

The [Horizon](#) is set to change this with its unique blended wing design. Instead of the traditional separation between the wing and the fuselage, the Horizon's wings and body flow seamlessly together, reducing drag and improving efficiency.

What is a blended wing body?

The Blended Wing Body (BWB) design has been around since the 1920s but has only seen real-world use in military aircraft, like the B-1 Lancer bomber. Unlike a flying wing (which is all wing) or a lifting body (which lacks wings), the BWB merges the wing and fuselage into one smooth surface. This innovation creates more lift with less drag, making it a highly efficient design for aviation.

The advantages of BWB

One major benefit of the BWB is the absence of a joint between the wing and the fuselage. This design minimizes drag and maximizes efficiency. Additionally, because the entire structure works together to create lift, less fuel is needed for flight. Another key advantage is the added interior space. With no traditional wing-body separation, more room is available for passengers, cargo, or even fuel storage. This is especially important as the aviation industry looks toward hydrogen-powered planes. A BWB design can accommodate large hydrogen tanks and their supporting systems, making it a viable option for the future of sustainable aviation.

Natilus's vision for the Horizon

Natilus has big plans for its Horizon BWB aircraft. The Horizon will be able to carry 200 passengers on intercontinental flights, all while slashing emissions by 50% and fuel consumption by 30%. With 40% more interior space, the Horizon will have a payload capacity comparable to current narrow-body aircraft like the Boeing 737 and Airbus A320. This is a bold move, especially considering the increasing demand for airliners and the current struggles of major players like Boeing.

The challenges of competing with Boeing and Airbus

The aviation industry is dominated by Boeing and Airbus, and for good reason. These two companies have a stranglehold on the market, and challenging them is no small task. While Natilus's BWB technology offers major advancements, it faces several hurdles. One major obstacle is airport infrastructure. Blended wing aircraft, like the Horizon, may require modifications to existing airports to accommodate their unique design. However, Natilus has stated that the Horizon is already compatible with current airport layouts. Another challenge is passenger comfort. With the BWB design, passengers may find themselves far from windows, as the plane's body will curve in a way that limits traditional window placement. This could be a tough sell for travelers who value the view from their seat.

What if Boeing or Airbus join the race?

While Natilus has made significant strides with the BWB concept, there's nothing stopping Boeing or Airbus from developing their own versions. The two giants have vast resources, and they could pivot to this new design if they see it gaining traction in the market. Additionally, there's always the possibility that a larger company might choose to acquire Natilus, as has happened in the past with innovative startups. In either case, Natilus faces a competitive future.

A glimpse into the future of aviation

Despite the challenges, Natilus is optimistic about its Horizon aircraft. The company plans to have the Horizon ready for customers by the early 2030s, offering a more sustainable and efficient solution for air travel. "The commercial aviation industry is looking for real solutions to become more sustainable, more efficient, and more profitable," said Aleksey Matyushev, CEO and co-founder of Natilus. "With the Horizon, we're introducing improved aviation economics that benefit the industry while helping safeguard our planet for future generations."



Horizon's role in a greener future



The SR-91 Aurora, colloquially known simply as Aurora, was a codename assigned to a hypothetical United States reconnaissance aircraft believed to possess the capability of hypersonic flight, reaching speeds of Mach 5 or greater. Speculations surround its development in the late 1980s or 1990s, with the intention of replacing the outdated and financially burdensome SR-71 Blackbird.



In May 2006, a British Ministry of Defence report mentioned USAF plans to develop a Mach 4-6 supersonic vehicle but thus far there has been no conclusive evidence that such a vehicle exists operationally. Some believers in the Aurora craft say that it was canceled as a platform, to free funds for Top Secret unmanned aircraft and reconnaissance satellites that can perform the same role, without risk to crewmen.

The question ultimately begging is: Does the US Air Force or America's intelligence agencies have some kind of hypersonic craft capable of Mach 6 performance as a secret payload? Increasing evidence points to this possibility. Recently, one of the more notable pieces of evidence to this claim concerns the sighting of a triangular aircraft over the North Sea in August of 1989 by oil exploration engineer Chris Gibson. Even more speculation about Aurora's existence has arisen from the "sky quakes" that have been heard over Los Angeles since the early '90s and were traced back to the spooky Groom Lake (Area 51) installation in Nevada.

The name "Aurora" came into wide use when a budget report for 1985 listed it among the SR-71 Blackbird and U-2 beneath the italicized heading "Aurora". Even if this was the project's actual name, it would likely have been changed after such a compromise.

It is hidden like the real name and existence of the plane, analogous to what happened to the F-117a stealth fighter, kept close to the chest for over a decade after the first pre-production test flight up until the recent un-classified publishing of information. The Aurora is a special access program, a black program, commonly referred to as such.

The first real evidence of it, was March 6, 1990, when a Lockheed SR-71 Blackbird jet broke the official airspeed record in flying from Los Angeles to Washington's Dulles Airport. That incident also sealed the SR-71's retirement, citing an official policy and financial savings from the line-of-command operational budget of \$200 - \$300 million annually. But its failure to fight the aircraft's retirement, and the fact that it reportedly squelched any congressional attempt to revive the program, also clearly made the office an accomplice. Aurora may be the key to the disappearance of the SR-71.

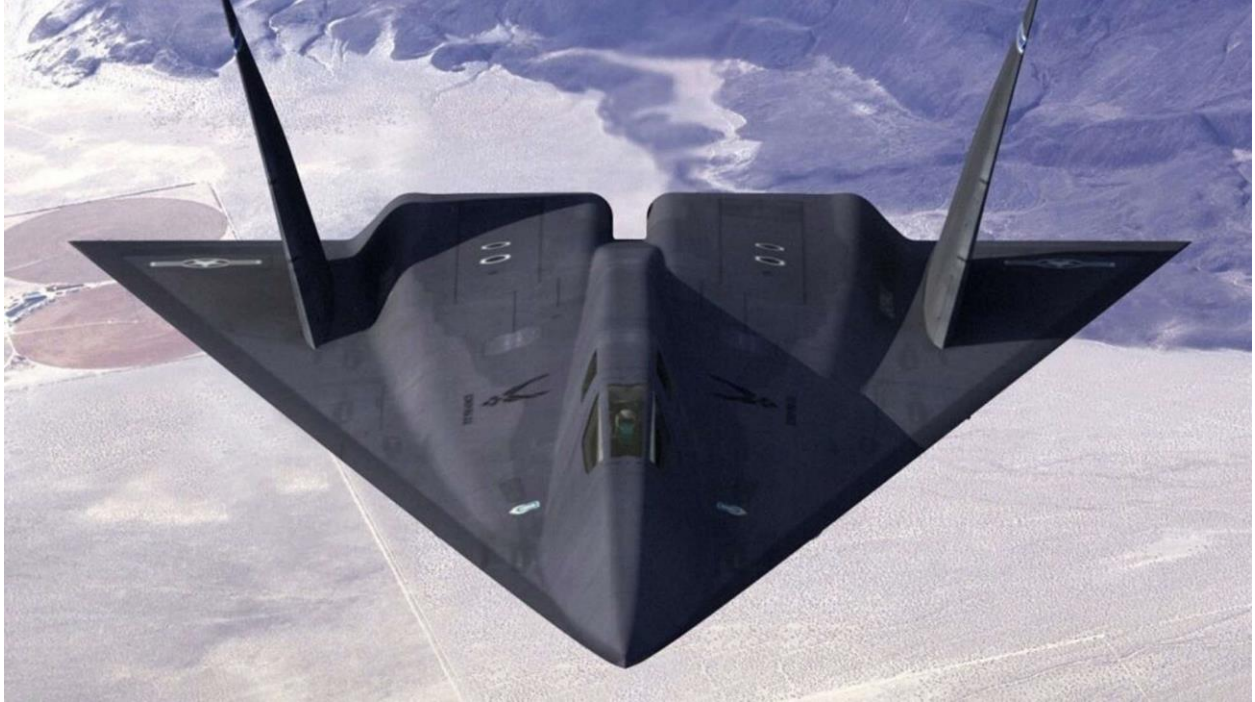
Public testing of such a radically new type of aircraft is monstrously expensive and logistically forbidding, not only in design and development but in the provision of a secret test location. The balance of the evidence indicated that Aurora's primary test site is the pre-existing facility of Groom Dry Lake in Nevada, which hosts the most secretive proving ground in America's elite. Comparing images of Groom Lake from the 1970s and today, enormous expansions are revealed: a six-mile-long lake-bed runway, which is twice the length of the longest normal runways in the United States. This long runway has to support airplanes with really high minimum speeds at flying and be optimized for way high maximum speeds.

It is almost certain that the prime contractor for the SR-91 Aurora aircraft would be Lockheed's Skunk Works, now the Lockheed Advanced Development Company. In the 1980s, for example, financial analysts noted that Lockheed was pursuing several high-dollar classified projects, but could only find a scant few projects that added up to the large amounts of money that seemed to be going into the company. Skunk Works has the singular distinction of being able to execute billion-dollar, high-risk programs under the shroud of an unparalleled level of secrecy while still meeting its commitments continually.

Aviation writer Bill Sweetman in 2006 said "20 years of examining budget 'holes,' unexplained sonic booms, and the Gibson sighting help establish the program's initial existence." Sweetman's investigations continue to uncover evidence suggesting current activity, including a \$9-billion "black hole" in the Air Force operations budget that seems a perfect fit for a project like Aurora.

The enigmatic SR-91 Aurora, with some tantalizing clues but few coherent, balances between outright proof of its existence and one of the most intriguing mysteries in modern military aviation. Related images you might be interested.

The SR-91 Aurora, colloquially known simply as Aurora, was a codename assigned to a hypothetical United States reconnaissance aircraft believed to possess the capability of hypersonic flight, reaching speeds of Mach 5 or greater. Speculations surround its development in the late 1980s or 1990s, to replace the outdated and financially burdensome SR-71 Blackbird.



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U.S. Navy to Develop F/A-XX Next-Generation Fighter Independently of Air Force NGAD



A previous artistic rendering of a design for a sixth generation F/A-XX fighter aircraft proposal. (Image: Boeing)

The Navy's decision could shield the F/A-XX program from the impacts of the Air Force's NGAD

review, especially as the source selection process is ongoing, with a winner expected next year.

Similarly to the U.S. Air Force, the U.S. Navy is developing a 6th generation fighter jet, [called F/A-XX](#). While the Air Force previously said the two programs are interconnected and is sharing its developments, the Navy has now said that it will develop its aircraft independently.

The revelation was part of an [interview](#) released to *Aviation Week* by Rear Adm. Michael Donnelly, director of the air warfare division in the Office of the Chief of Naval Operations. The Navy, since the beginning, has always been tightlipped about the secretive Next Generation Fighter, with few details released.

The Navy is currently in the source selection phase, with proposals from three companies, as [confirmed](#) by both Donnelly and Admiral Lisa Franchetti, the Chief of Naval Operations. While not explicitly stated, the three companies are believed to be Boeing, Lockheed Martin and Northrop Grumman.

The F/A-XX contract is planned to replace both the F/A-18E/F and EA-18G, complementing the [F-35C](#) in the Carrier Air Wings. Fiscal pressure and tight budgets, however, could delay the entire process and, as a consequence, the fielding of the new aircraft.

F/A-XX and NGAD

According to Rear Adm. Donnelly, the new carrier-based fighter will be affordable, versatile and independent of [Air Force-funded technologies](#) such as an adaptive-cycle turbofan engine. While the service already said it would require a different airframe than the Air Force's NGAD, however, other systems were not mentioned.

Initially, the Navy appeared interested in the adaptive-cycle technology being developed for the [Next-Generation Adaptive Propulsion](#) (NGAP) program. In the past decade, however, propulsion plans for the two services have diverged, according to Donnelly.

"We're looking at more of a derivative-type engine solution," said Donnelly. "That's just one example where we probably are different in many ways from the Air Force. In totality, they are two unique programs from an acquisition point of view and also going forward, so we're relatively independent of each other at this point."

As reported earlier, the Air Force's Next Generation Air Dominance (NGAD) is currently undergoing an [extensive review](#) that could reshape its future and have major implications for the Air Force's approach to air superiority. The Navy's decision to move forward independently might shield the F/A-XX from the results of the NGAD's review and the subsequent decisions.

One of the aspects of NGAD currently being reviewed is the [cost](#), which is expected to be in the hundreds of millions per aircraft and has not been deemed affordable. On the other hand, the Navy is still confident in the suitability and affordability of the F/A-XX and is committed to move forward with the program.

"We have to have an affordable platform to make it relevant to our force structure and force design, so we've got that in mind," said Donnelly. "We think we've got an affordable solution that supports our force structure of the future."

According to Donnelly, the F/A-XX program is on track for the [Milestone B decision](#) to move the Engineering and Manufacturing Development (EMD) phase by the end of fiscal year 2025. In fact, contrary to the Air Force, the Navy appears to be happy with the current performance requirements it has put out for the Next Generation Fighter.

"We feel really good through the concept development that we've got the right bracket for those requirements and the attributes we need to deliver the capability," Donnelly says. "We'll continue to look at that as we go through the next phases of the acquisition process and make smart decisions."



An F/A-18F Super Hornet, assigned to Strike Fighter Squadron (VFA) 25, launches off the flight deck of the Nimitz-class aircraft carrier USS Theodore Roosevelt (CVN 71) in the South China Sea, June 10, 2024. (U.S. Navy photo by Mass Communication Specialist Seaman Apprentice Aaron Haro Gonzalez)

However, both programs appear to be under budgetary pressure, as both services are currently working on multiple large programs. In the Navy's case, the [2025 budget](#) for the new aircraft suffered a cut of 67%, with the \$10.3 billion requested between 2025 and 2028 reduced to just \$3.3 billion. The senate voted to restore \$450 million to the budget but, even if approved, there would still a cut of 59% compared with last year's budget.

"Any time we are causing budget perturbations, we've got to consider what that does to schedule," said Donnelly. "But obviously the later we wait, the more challenging it is to continue to pull that [schedule to the] left."

Another difference between the Navy's and Air Force's [6th gen fighter](#) could be their roles. While the latter envisions its new aircraft mainly as an air superiority fighter, the Navy wants it to be multirole, optimized for air-to-surface strike but still capable of fleet defense.

"The central focus of its design is to be able to conduct long-range fires, sea control and those types of missions. Inherent in its design is its ability to participate in fleet defense," Donnelly says. "We can't afford to have a break-glass capability or a really unique single-mission or single-phase-of-operation focus."

As explained by *Aviation Week*, the Navy traditionally divides its fighters assigned to carrier air wings between two primary missions: air-to-surface, also defined as long-range strike and sea control, and air-to-air, also known as fleet defense. The former is primarily assigned to the F-35C, while the latter is assigned to the [F/A-18E/F](#), which entered service initially with the long-range strike role.

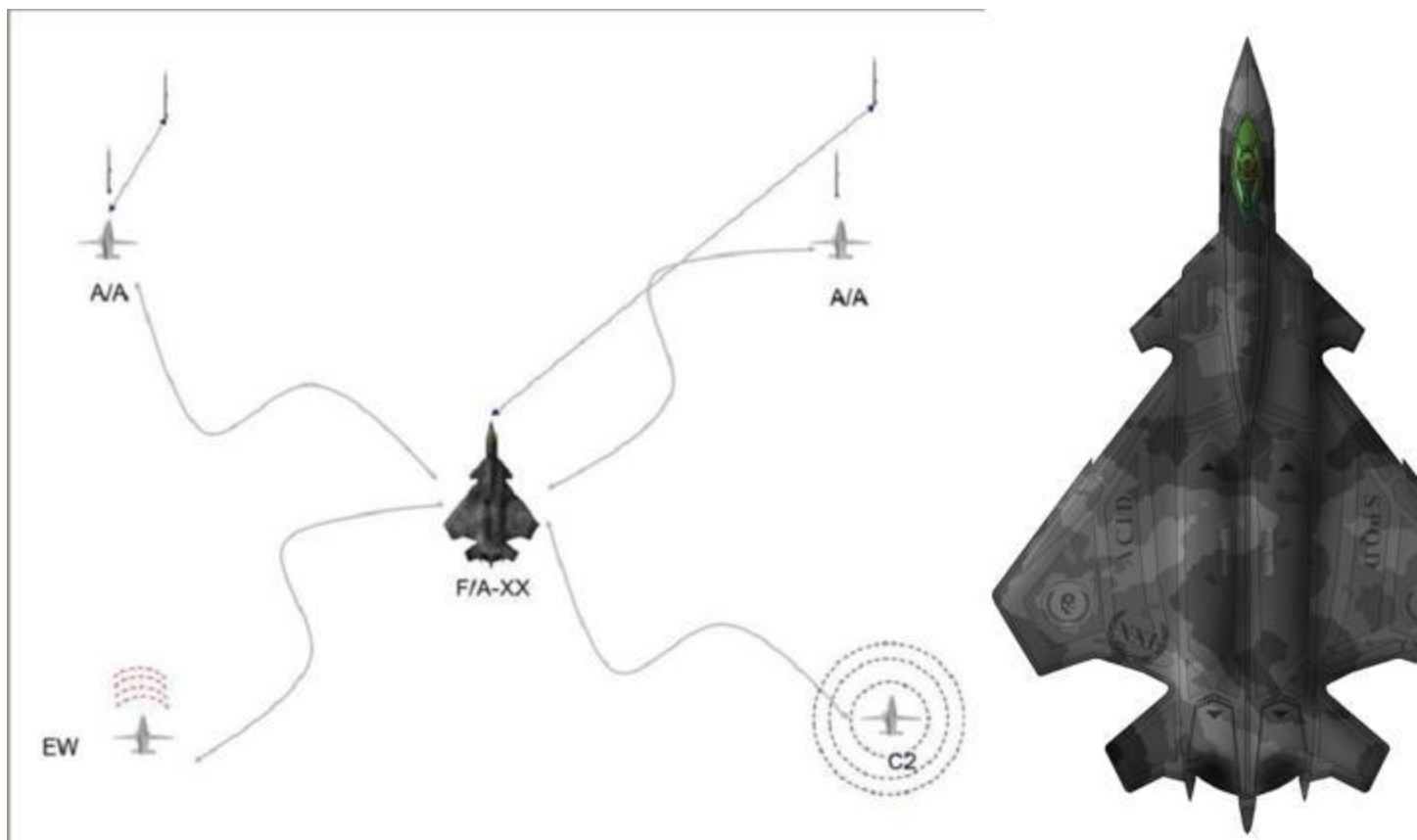
A final difference is the manned or unmanned debate. The Air Force left the door open for an [optionally manned configuration](#), which was also the initial configuration proposed for the F/A-XX. However, the Navy has now opted for a fully manned platform.

"F/A-XX is intended to be a manned platform," Donnelly says, noting that the "F/A-XX will really be our pivot point from a manned air wing to a hybrid future, with a manned-unmanned air wing."

What we know about F/A-XX

The F/A-XX is the strike fighter component within the Next Generation Air Dominance (NGAD) Family of Systems (FoS). The requirement for this aircraft has been around since 2008, with a formal Request for Information in 2012, to replace the F/A-18E/F Super Hornet in the 2030s.

Later, the F/A-XX was included in the NGAD program which, by the way, is a separate program from [the identically named Air Force program](#). The Navy says that its "specific capabilities and technologies are under development, however analysis shows it must have longer range and greater speed, incorporate passive and active sensor technology, and possess the capability to employ the longer-range weapons programmed for the future".



The F/A-XX placeholder design as shown by the U.S. Navy in its vision for 2030-2035, together with a better image of the original fictional design. (Images via U.S. Navy and Tapataalk)

The NGAD FoS will include unmanned platforms with F/A-XX as the quarterback, exploiting the Manned/UnManned Teaming (MUM-T) concept to reduce risk to the manned aircraft, while simultaneously increasing capability, capacity, and survivability. The [new MQ-25 Stingray](#) will be the first unmanned asset to employ this capability, extending the strike range and enhancing maneuverability of the Carrier Air Wing.

Continued development of MUM-T will enable information sharing across a distributed force, increasing survivability, reducing risk to manned aircraft, and ensuring weapons capacity. The Navy is evaluating the appropriate mix of F/A-XX, manned and unmanned platforms to ensure the most lethal and affordable CVW possible, depending also on the maturity of autonomy and Machine Learning technologies.

The Navy envisions future unmanned air vehicles with survivable platforms, sensors, and robust autonomy able to find, fix, identify, track, engage, and assess land, sea, and air targets. These UAVs will be employed alongside manned aircraft

and [unmanned attritable assets](#) to enable integrated kinetic and non-kinetic fires at tactically relevant ranges in multidomain operations.

In a 2021 document, the Navy showed a fictional F/A-XX operating in a MUM-T environment with four drones, whose shape represents the [MQ-25](#). Interestingly, the drones are shown employing Air-to-Air (AA), Electronic Warfare (EW) and Command and Control (C2) payloads, much like [the Loyal Wingman drones](#) currently being developed. This falls in line with the service envisioning Unmanned Air Systems (UAS) to fill refueling, communications relay, logistics, airborne electronic attack, strike, and ISR&T missions in the future air wing.

The post [U.S. Navy to Develop F/A-XX Next-Generation Fighter Independently of Air Force NGAD](#) appeared first on [The Aviationist](#).

The Collaborative Combat Aircraft Could Transform the Air Force



Collaborative Combat Aircraft

What You Need to Know: The U.S. Air Force's **Collaborative Combat Aircraft (CCA)** program has reached a major milestone, with Anduril's "Fury" and GA-ASI's "Gambit" unmanned aerial systems passing critical design review.



Gambit or Collaborative Combat Aircraft

-These unmanned systems are part of the broader Next Generation Air Dominance (NGAD) initiative, which has paused development of a sixth-generation manned fighter. The CCA, designed for affordability and scalability, aims to deliver at least 1,000 units by 2030. These "loyal wingmen" will support manned fighters in roles like reconnaissance and decoy operations, focusing on cost-effective mass production.

-Maiden flights are set for 2025, with production contracts expected in FY26.

The Collaborative Combat Aircraft is Coming Into Focus

The future of the [U.S. Air Force's Next Generation Air Dominance](#) (NGAD) [program isn't clear](#) – as the service has put the efforts to develop a sixth-generation manned fighter on pause – but one of the related systems continues to move forward. Earlier this year, Anduril and General Atomics Aeronautical Systems (GA-ASI) were awarded contracts to continue the development of [Collaborative Combat Aircraft](#) (CCA), the unmanned aircraft component.

The designs from the two firms have now passed the critical design review (CDR) stage, a key milestone in Increment 1 for the program. This clears the way for the two companies to move to the production phase.

"We've just finished up, basically, critical design review for both Anduril and General Atomics. Both industry teammates are on the path to get to first flight in a timeline that allows us to get operational capability by the end of the decade," Col. Timothy Helfrich, senior materiel leader for Air Force Materiel Command's Advanced Aircraft Division, said during a panel at the Mitchell Institute's Airpower Futures Forum, [per DefenseScoop](#).

Beating Out the Aerospace Giants

Anduril's "Fury" and GA-ASI's "Gambit" unmanned aerial systems (UAS) were selected [over competing offerings](#) from Boeing, Lockheed Martin, and Northrop Grumman.

All three companies had originally been competing for the contract to develop the [sixth-generation manned fighter](#) that was to be the centerpiece of the NGAD program, but Northrop Grumman withdrew – only to later state it might [jump back in](#). While the program is officially paused, it is likely that the research and development (R&D) and design work continues at the respective companies.

It is likely a matter of when, not if, the Air Force opts to pursue a sixth-generation fighter. However, it may be focused on what the CCA brings to the table.

"The CCA program aims to deliver at least 1,000 CCAs, prioritizing cost-effective scalability. With air superiority pivotal to America's military dominance for more than 70 years, CCA offers expanded fighter capacity (affordable mass) at reduced costs and adaptable timelines," the [Air Force announced](#) in the spring.

Maiden flights of the respective designs from Auduril and GA-ASI are expected to take place in 2025, while a production contract is currently on track to be awarded during fiscal year 2026 (FY26), which begins on October 1, 2025. The Air Force has called for the CCA to enter service by 2030.

Not a Sixth-Gen Aircraft

It is also important to note that the CCA won't be the most advanced aircraft to take flight. While UAS were among the system of systems that made up the NGAD program, are meant to complement and support a manned fighter, not replace it.

Thus while these "loyal wingmen" could be used in a variety of roles, including reconnaissance and even acting as decoys, the aircraft are being designed to be low cost – and while not disposable, that focus is on affordable mass, which means they can be more easily replaced than the expensive manned fighters.

Inside the E-4B “Nightwatch”: Built to Protect the President During a Nuclear Strike



Photo: Youtube© Photo: Youtube

The E-4B "Nightwatch," often called the "Doomsday Plane," is one of the most advanced and expensive aircraft operated by the U.S. Air Force.

Designed to protect the President of the United States during catastrophic events, including a potential nuclear attack, it doubles as a mobile command and control center in the event of an apocalyptic scenario.

Unlike Air Force One, which serves primarily as a flying office for the President, the E-4B can operate as a full-scale military strategy hub.

With a construction cost of \$223.2 million and operating costs of \$159,529 per hour, it is the most expensive aircraft in the U.S. Air Force fleet, according to [Ziare](#).

The E-4B is a militarized version of the Boeing 747-200. The fleet of four planes is based at Offutt Air Force Base in Nebraska, home to the National Airborne Operations Center.

The aircraft is equipped with advanced shielding against nuclear blasts and electromagnetic pulses, ensuring its systems remain operational in extreme conditions.

Also read

[Russia Loses \\$200 Million in Minutes as Ukraine Strikes Again](#)

Accommodate 112 Passengers

It features extensive communications capabilities, including 67 satellite and other antennas housed in a specialized "radome."

This setup allows the E-4B to maintain superior communication functions compared to Air Force One. The aircraft can refuel mid-air, enabling it to remain airborne for days at a time if necessary.

The E-4B's interior is divided into six functional zones, including a command center, briefing room, conference area, and rest quarters.

It can accommodate up to 112 passengers, including military officials, staff, and media personnel. The Secretary of Defense often uses the aircraft for international travel, with private quarters featuring a bed and office space.

On alert 24/7 since its introduction in 1975, at least one E-4B is always ready for deployment.

In the event of a nuclear attack or another national crisis, the President, Secretary of Defense, and the Chairman of the Joint Chiefs of Staff would use the E-4B as a secure, airborne Pentagon.

The E-4B "Nightwatch" is a testament to the U.S. military's readiness for worst-case scenarios, ensuring continuity of government and military command under any circumstances.

'Son of Concorde' that can fly to New York in 3.5hrs reaches new heights

A plane dubbed the 'son of the Concorde' that could fly from [London](#) to [New York](#) in three and a half hours has completed its eighth test.

The XB-1 jet, which engineers are hoping could reach supersonic speeds, has been undergoing test flights since March of this year.

During a flight which lasted around 54 minutes on Saturday, the plane reached an altitude of 25,040ft, surpassing its previous record of around 23,000ft.

And engineers don't intend on stopping there. The plane is set to fly higher, and faster until it eventually reaches the speed of sound – Mach 1.

The jet's [latest test run](#) confirmed that flying at speeds of Mach 0.8 is safe, even with the stability augmentation system turned off.

The stability augmentation system is crucial in ensuring that aircrafts are safe. It enhances flight stability by automatically adjusting its controls.



Engineers want the XB-1 to reach the speed of sound

The team behind the new plane said: 'XB-1 cleared this requirement, confirming that the pilot can safely control the aircraft at higher speeds even in the event of a stability augmentation system failure.

'While XB-1 does have this kind of system, called the stability augmentation system, the team is assessing the aircraft with the system off at increasing speeds.

'This is a requirement prior to supersonic flight that XB-1 successfully cleared during this flight.'

Last week, during its seventh test flight, the XB-1 reached its fastest speeds yet of Mach 0.82.

The Colorado company behind the new jet is now set to put their creation through two more test flights to confirm its performance and handling qualities.

Before it was banned in the UK, the Concorde could reach speeds of Mach 2.



The experimental jet reached new heights on its eighth test flight

For reference, modern fighter jets, which are smaller than the Concorde, fly at speeds between Mach 1.2 to Mach 2.5.

Supersonic flights were banned in the UK because they were so expensive to operate and deemed too noisy.

But now, there are an increasing number of companies trying to build suitable supersonic aircraft with regulators urged to review their bans.

F-35 Fighter Is Becoming a \$2,000,000,000,000 Headache



F-35 Fighter

What You Need to Know: The cost of the **F-35 Joint Strike Fighter** is expected to exceed \$2 trillion over its lifespan, according to a new **GAO report**, marking a 44% increase in sustainment costs since 2018. Rising inflation and an extended operational timeline—from 2077 to 2088—are key drivers of the cost spike.



F-35© Provided by National Interest

-Efforts to reduce costs, including contract adjustments and reduced flight hours, have seen limited success. Despite these investments, the F-35 struggles with mission-capable rates well below targets, raising questions about the program's value.

-With a mission-capable rate of only 52% for the F-35A, critics view it as a cautionary tale of runaway military spending.

F-35 Fighter Costs: Reaching a Breaking Point?

The cost of the F-35 Joint Strike Fighter keeps rising and rising. A report from the Government Accountability Office (GAO) shows that costs for the fifth-generation F-35 are expected to exceed \$2 trillion over the jet's lifespan. The GAO's new estimate represents a forty-four percent increase in sustainment costs over the last estimate, made in 2018. The massive increase stems from U.S. military plans to fly the F-35 longer than originally intended and rising inflation.

Runaway Costs

In 2018, the GAO estimated that the F-35 program would incur \$1.1 trillion in sustainment costs. The sustainment costs, paired with the \$442 billion in acquisition costs, which included development and procurement of the [F-35](#), combined to represent the entire cost of the [F-35 program](#). The GAO's new estimate, however, shows a spike in sustainment costs from \$1.1 trillion to \$1.6 trillion, a forty-four percent increase, which will push the program's entire cost north of [\\$2 trillion](#).

The cost increase can be attributed, in part, to the Pentagon's plans to fly the F-35 for eleven years longer than originally intended; rather than retire the F-35 in 2077, the Pentagon now plans to fly the jet through 2088. But the extended lifespan is only part of the problem.



F-35

"Rising inflation is a major factor driving up the cost of flying the F-35," Defense News [reported](#). "And while the F-35 program has made attempts to bring costs back down, the report noted those efforts have had only limited success."

The F-35 Joint Program Office explained their cost-cutting efforts in a statement to Defense News: "We have continued to reduce sustainment costs through growth and maturation of the F-35 enterprise, including JPO product support manager efforts to drive down contract costs, better alignment of U.S. services' requirements and budgets, and an active cost reduction initiative pipeline."

The efforts have had some success, between 2014 and 2022, the cost per F-35 fell from \$9.4 million to \$6.2 million while the cost per hour to operate the F-35 fell from \$86,800 to \$33,600.

Part of the cost reduction effort has been a reduction in flight time per jet, which partially defeats the purpose of having the jet. In 2020, projections held that the F-35 fleet would be flying about 382,000 hours per year by the mid-2030s. But that projection has been reduced to barely 300,000 hours per year.

The F-35 has proven to be a cautionary example of military spending. Despite the massive investment in the F-35, the jet is still failing to meet [mission-capable](#) rates. The [F-35A](#), for example, had a mission-capable rate of just fifty-two percent in 2023. The minimum target rate is eighty percent. The F-35B had a mission-capable rate of sixty percent while the F-35C held a sixty-two percent rating.

Both variants have a target rate of seventy-five percent.

The inability of the F-35 to be consistently ready for action calls further into question the amount spent on the program.

US Navy's 6th-gen fighter pursues unique design, independent of Air Force NGAD



US Navy's 6th-gen fighter pursues unique design, independent of Air Force NGAD

The US Navy is moving forward with plans for the F/A-XX, a new fighter jet designed to replace the aging F/A-18E/F Super Hornet.

This aircraft aims to be cost-effective, versatile, and independent of Air Force technologies, particularly those used in the Next-Generation Air Dominance (NGAD) platform, which relies on advanced adaptive engines.

While the Navy and Air Force are developing new fighter jets, their approaches differ significantly.

The Air Force focuses on high-tech aircraft with cutting-edge engines, which increases costs.

In contrast, the Navy emphasizes affordability and practicality with “derivative-type engine solutions” to avoid the Air Force’s acquisition delays and budget overruns.

US Navy 6th-gen fighter

In a recent interview with *Aviation Week*, Rear Adm. Michael Donnelly, director of the air warfare division in the Office of the Chief of Naval Operations, highlighted that the Navy’s new carrier-based fighter will be affordable and versatile.

However, it may still face financial constraints that could impact its timeline.

His comments arose amid a competitive contract selection among Boeing, Lockheed Martin, and Northrop Grumman for the F/A-XX project.

This further distances the Navy’s fighter jet from the Air Force’s paused NGAD acquisition process.

The Navy has previously stated that the F/A-XX will require a different airframe than the Air Force’s next fighter, ending speculation about a multiservice program.

However, whether the to-be-seen will share a propulsion system with the [NGAD](#) remains unclear.

Over the last decade, the propulsion strategies of the Air Force and Navy have diverged.

The Air Force is advancing its Next-Generation Adaptive Propulsion (NGAP) technology, part of the NGAD program’s funding initiatives.

Independent of Air Force NGAD

Conversely, the proposals for the F/A-XX rely on older engines without the adaptive features found in next-generation options.

“We’re looking at more of a derivative-type engine solution,” Donnelly explained, suggesting significant differences between the two services regarding their programs and acquisition strategies.

This independent approach enables the Navy to safeguard the F/A-XX program against potential repercussions from changes in the Air Force’s plans.

Navy officials maintain confidence in the F/A-XX’s suitability and affordability, noting that work on the new fighter began several years before the Air Force initiated its efforts. The first market survey for F/A-XX concepts was issued in 2012.

Donnelly affirmed that a Milestone B decision to launch the engineering and manufacturing development phase is scheduled for the end of fiscal 2025.

He emphasized the necessity for an affordable [platform](#) to ensure relevance within the Navy’s force structure and design for the future, asserting, “We think we’ve got an affordable solution that supports our force structure of the future.”

Despite both programs facing similar financial challenges, their trajectories remain separate.

The Air Force is contending with the rising costs of a new intercontinental ballistic missile, which affects other priorities such as ramping up Northrop Grumman B-21 production and advancing new development projects.

Simultaneously, the Navy is tasked with developing a nuclear submarine, a new destroyer, and the next-generation fighter, all contributing to capacity shortfalls within its existing fleet.

Fiscal constraints have already imposed cuts, with the Navy’s fiscal 2025 budget reducing planned spending on the F/A-XX by 67% from fiscal 2025 to 2028, lowering the projected budget from \$10.3 billion to \$3.3 billion.

Supersonic passenger planes 1 step closer to return after successful Boom XB-1 test flight nears sound barrier



Supersonic passenger planes 1 step closer to return after successful Boom XB-1 test flight nears sound barrier© Boom Supersonic

Boom Supersonic has set a new speed record for its XB-1 prototype aircraft while confirming the stability of its design at high speeds for subsonic flight. The successful test puts us one step closer to seeing the return of commercial supersonic flights — 21 years after Concorde retired.

On Nov. 5, the XB-1 hit 629 mph (1,012 km/hr) for the first time — equivalent to Mach 0.82, where Mach 1.0 is the [speed of sound](#). Marking its seventh test flight,

this 55-minute mission also reached a new flight ceiling of 23,015 feet (7,015 meters) and confirmed the safety of its cockpit pressurization systems.

Eleven days later, the XB-1 completed its eighth test flight, a 54-minute run in which it carried out sustained Mach 0.8 operations without the assistance of its stability augmentation system. This automated system typically helps keep the XB-1 stable during flights, similar to the [fly-by-wire](#) electronic stabilization systems used in modern fighter aircraft. Boom Supersonic wanted to demonstrate that the XB-1 is not entirely dependent on its stability augmentation system to stay in the air and can be manually operated at high speeds safely, [the firm stated](#).

The aircraft has been in development for eight years and completed its first test flight in 1 March 2024 – which lasted just 12 minutes.

Other recent milestones include successful "flutter" tests at high speed, which prove the structure of the aircraft is not susceptible to destructive vibrations caused by airflow at high speeds, and the [first successful in-flight use of its landing gear](#).

Boom Supersonic aims to complete 10 subsonic flights before pushing ahead with supersonic tests by the start of 2025.

"XB-1 continues to perform at progressively faster speeds and higher altitudes, expanding the flight envelope gradually to prepare the aircraft and team for breaking the sound barrier at Mach 1," Boom Supersonic representatives said in [a statement](#).

The XB-1 is a demonstrator craft, intended to make a case for the company's technology to one day be used in commercial operations. These test flights are stress-testing Boom Supersonic's in-house carbon fiber composite blends for airframes, as well as its custom engine intakes, which help traditional turbojet engines accelerate up to supersonic speeds more efficiently.

The XB-1 tests will feed directly into the creation of the Boom Overture, a proposed [supersonic passenger aircraft](#) capable of traveling as fast as Mach 1.7 — or 1,304 mph (2,099 km/h). This is nearly [as fast as the Concorde](#) and would enable passengers to travel from London to New York or Newark in approximately 3 hours and 30 minutes.

The Boom XB-1 reaches new milestone, paving the way for supersonic commercial aviation

[Boom Supersonic](#) is on a mission to bring Mach 1 speeds to commercial aviation. The company got closer on November 16 when its XB-1 aircraft approached supersonic flight. The XB-1 is a test bed for the company's planned Overture aircraft, designed to bring the speed of sound to everyday air travel. Boom continues its measured, step-by-step approach to making that a reality.

On its latest flight, the Boom XB-1 neared supersonic speeds



Boom Supersonic XB-1 Boom Supersonic

The XB-1's November 16 [test flight](#) was its eighth of ten planned sessions. During the eighth flight, Boom measured the aircraft's handling with its stability augmentation system switched off. The XB-1 passed the test, showing that a pilot can safely control high-speed flight in case of a system failure. During the 54-minute flight, the maximum altitude was 25,040 feet, and the maximum speed was Mach .82. With each subsequent test, the aircraft continues to fly faster and higher as it approaches the sound barrier.

Boom Supersonic commented on the test: "Designing a plane that is both very stable and very fast is a challenge, especially for high-speed aircraft like XB-1. One of the major accomplishments of the XB-1 program was converging on a design that does not rely on computerized augmentation to stay safe in the air, unlike many modern fighter jets that use automated systems to make constant adjustments to the flight path in order to maintain stability. While XB-1 does have this kind of system, called the stability augmentation system, the team is assessing the aircraft with the system off at increasing speeds—this is a requirement prior to supersonic flight that XB-1 successfully cleared during this flight."

Lockheed X-24C: The Hypersonic Mach 8 Plane Explained in 3 Words



Lockheed X-24C: The Hypersonic Mach 8 Plane Explained in 3 Words© Provided by National Interest

What You Need to Know: The Lockheed L-301, also known as the X-24C, was an ambitious experimental hypersonic aircraft project in the 1970s that aimed to build upon the advancements of the X-15 and X-24B programs.



X-24

-Designed to reach speeds of Mach 8 and perform hypersonic skip-glide maneuvers, the X-24C was intended to utilize a combination of rocket engines and a hydrogen-fueled air-breathing ramjet/scramjet.

-Despite its potential to propel the U.S. ahead in hypersonic technology, the program was canceled in 1977 due to budget constraints.

How the Abandoned X-24C Project Left the U.S. Behind in Hypersonic Tech

Today, the U.S. lags behind Russia and China in operational hypersonic weapons, highlighting the significance of the X-24C's unrealized promise. The aircraft remains a fascinating concept that exists only as an unfulfilled blueprint.

The annals of aviation history is littered with canceled projects, concepts that for one reason or another never came to be. The projects remains as blueprints, never to be built or flown. One such cancelled project was the Lockheed L-301, or X-24C, an experimental air-breathing hypersonic aircraft that was decades ahead of its time.

While the X-24C program never got off the ground, in January 1977, the program was “tentatively scheduled to operate two vehicles for eight years and to conduct 100 flights per vehicle.” But by September 1977 – just nine months later – NASA and the United States Air Force’s National Hypersonic Flight Research Facility (NHRF), who contracted with Lockheed Martin’s Skunk Works to lead the project, abandoned the X-24C for the same reason so many promising aviation projects were abandoned: budget constraints.

X-24C: What could have been

The X-24C was expected to build upon the advancements of the X-15 and the X-24B programs. The X-15 was the vaunted hypersonic rocket-powered aircraft that the USAF and NASA operated.

The X-15 was a remarkable machine, depicted recently in the film *First Man*, in a recounting of an incident one-time X-15 pilot Neil Armstrong had, in which he “skipped” his X-15 off the atmosphere of the Earth. The USAF and NASA had once considered controlled flight (as in the X-15) to space rather than the capsules-launched-atop-a-rocket scheme (as in Mercury, Gemini, Apollo) that eventually won out; the [X-15](#) was the culmination of the fly-to-space trials.

The X-24B, meanwhile, was an experimental aircraft that was designed to build and test lifting body concepts. The X-24B was used to test unpowered reentry and landing – a technique that the Space Shuttle would later use.

The X-24C was to take the lessons learned during the X-15 and X-24B projects, with the expectation that the X-24C would be able to reach Mach 8 speeds and perform hypersonic skip-glide maneuvers for long range missions.

Scramjet Engine for X-24C

Initially, the X-24C was designed to carry the XLR-99 engine, which had been used previously on the X-15. But the design was changed; the XLR-99 was replaced with the LR-105, which was the sustainer engine used on the Atlas launcher. The LR-105 burnt RP-1 and LOX and was designed to bring the X-24C to hypersonic speeds, at which point the airframe's hydrogen fueled, air breathing ram/scramjet (mounted in the belly of the airframe) would ignite, propelling the X-24X to speeds in excess of Mach 8 and altitudes in excess of 90,000 feet.

The "scramjet propulsion concept is still widely considered to be the most likely candidate for hypersonic aircraft to this day," Alex Hollings [wrote](#) for Sandboxx. "A normal jet engine uses a compressor section (fan blades) to compress air to be mixed with fuel and ignited, but at hypersonic velocities, that compressor becomes a hindrance, slowing airflow to subsonic speeds as it passes through." A scramjet, however, "uses the immense pressure created by air flowing into the engine at supersonic speeds to handle compression, making it a far more efficient means of propulsion at such high velocities."

As NASA estimates, scramjets could be used to achieve speeds of Mach 15 or higher. To date, NASA has achieved speeds of Mach 9.6 using a scramjet (the X-43A unmanned hypersonic aircraft).

Had the X-24C project proceeded, the US would likely be much further ahead today with respect to scramjet technology. Today, however, the US lags "behind nations like Russia and China in fielding operational hypersonic weapons." Both [China](#) and Russia have already fielded [hypersonic](#) weapons. The US has not, although the Pentagon has indicated it will procure 24 hypersonic weapons next [year](#). Despite the US lag in fielding hypersonic weapons, billions have already been invested in the development of the cutting edge weaponry – which are expected to fundamentally change the way wars are [fought](#).

Why? Because [hypersonic weapons](#) will travel at about Mach 5, which means they will have enough kinetic energy to destroy targets without even using an explosive – and because to date, nothing exists that can coherently defend

against [hypersonic missiles](#). Anyways, had the X-24C program proceeded, the US likely would have fielded hypersonic missiles sooner.

Hollings is optimistic that, had the X-24C program proceeded, Lockheed Martin could have pulled off the impressive scramjet technology. "If *anyone* could make a hypersonic aircraft leveraging a combination of conventional and scramjet propulsion work in the 1970s, the guys who were making rocket-assisted F-80 fighters in the '50s and the space-scraping SR-71 in the '60s probably could."

We'll never know, however. The X-24C was a fascinating concept that exists now only as an unfulfilled blueprint.

Bee-like vertical landing electric aircraft showcases super propulsion system



Bee-like vertical landing electric aircraft showcases super propulsion system

Austrian aviation company CycloTech is preparing to test a new electric vertical takeoff and landing (eVTOL) aircraft demonstrator featuring its innovative “CycloRotor” propulsion system.

The company has been developing its 360-degree thrust vectoring technology for several years and aims to showcase the seventh generation of this system in its upcoming BlackBird flying car.

“CycloTech is introducing a new flying vehicle, the BlackBird demonstrator, that features a new propulsion system for any type of manned or unmanned aircraft but especially for flying cars,” said the company in a press release.

360-degree thrust vectoring

Unlike conventional propellers, CycloRotors are cylindrical devices capable of generating thrust in any direction along a 360-degree axis.

“This propulsion system is the only system that can control the thrust vector in strength and direction in a full circular path (360 degrees),” highlighted the company.

This omnidirectional thrust vectoring capability unlocks unprecedented maneuverability. This enables the aircraft to perform vertical takeoffs and landings, precise hovering, and even mid-air braking.

“CycloTech is the only company in the world currently working on the commercial application of CycloRotors as the main propulsion system,” asserted Hans-Georg Kinsky, CEO of CycloTech.

Unique design with enhanced safety

The BlackBird demonstrator will have six CycloRotors strategically integrated into the aircraft's design, with two positioned along its longitudinal axis. The aircraft's unique propulsion system ensures a smooth, turbulence-free ride, even during complex maneuvers.

"The 2 CycloRotors in the longitudinal axis of the aircraft enable lateral flight without banking the aircraft and increased maneuverability," explained the press release.

Additionally, the use of multiple CycloRotors guarantees redundancy, meaning that the aircraft can maintain control and stability even if one [engine](#) fails.

"That's why we at CycloTech use at least six CycloRotors to ensure that the aircraft can continue to fly in a controlled manner in the event of an engine failure," remarked Kinsky.

The BlackBird demonstrator will be a compact and agile vehicle, measuring 16 feet (4.9 m) in length, 7.5 feet (2.3 m) in width, and 6.5 feet (2 m) in height. Besides, it is projected to achieve a top speed of 75 mph (120 km/h).

"The new BlackBird demonstrator, with a maximum takeoff weight of 750 lb (340 kg), is now in development and expected to be completed by the end of 2024," added the [press release](#).

However, specific details regarding BlackBird's passenger capacity and [range](#) are yet to be made public.

Potential applications and future outlook

That said, one can expect a vast range of applications for the BlackBird. No doubt, it will function as a personal aerial vehicle to help individuals bypass ground-based traffic and swiftly navigate densely populated urban areas.

But it can also be used for more challenging tasks such as rescue operations, thanks to its ability to hover and land precisely even in adverse weather and terrain conditions.

The BlackBird demonstrator is scheduled for the first quarter of 2025. Notably, the competition in the flying car market is getting intense, with several companies, such as Volocopter, Airbus, and Joby Aviation, developing their own models to boost urban mobility.

[Boom Supersonic](#) is on a mission to bring Mach 1 speeds to commercial aviation. The company got closer on November 16 when its XB-1 aircraft approached supersonic flight. The XB-1 is a test bed for the company's planned Overture aircraft, designed to bring the speed of sound to everyday air travel. Boom continues its measured, step-by-step approach to making that a reality.

How NASA's X-59 recycled decades-old plane parts to make silent supersonic flight possible

NASA's X-59 Quesst experimental aircraft has taken a major leap forward, [firing up its engine for the first time](#). This marks a crucial and final milestone as the team prepares the first runway and flight tests that will lead to a long series of trials that aim to prove what computational simulations have already proven: that supersonic flight can happen without the deafening sonic boom that marred and eventually grounded aircrafts like the Concorde.

The X-59's goal—to transform that sonic explosion into a gentle thump—is an engineering challenge that its makers are addressing through a design that mixes [a couple of radically new technologies](#) with *a lot* of decades-old, battle-proven aircraft parts ingeniously repurposed to make it all work.

The engine run began on October 30, 2024, at the Lockheed Martin's Skunk Works facility in Palmdale, California. The tests verified that all systems of the aircraft were functioning together properly, powered by the aircraft's own engine rather than external sources used in previous evaluations. Jay Brandon, chief engineer for the X-59 at NASA, called the first engine run a "warmup" to make sure everything looked good before fully running the engine. "We then moved to the actual first engine start, which took the engine out of the preservation mode it had been in since installation," Brandon explains in [NASA's press release](#).

[Photo: NASA]

Lockheed Martin's Skunk Works design team, which is responsible for iconic secret planes from the old P-38 Lightning from Second World War to the SR-71 Blackbird, designed the X-59 in collaboration with NASA. From the start, the team knew that this plane couldn't afford to totally reinvent the wheel with new advanced technologies. There just was no money for that.

With a \$247.5 million budget—low for a cutting-edge, one-of-a-kind prototype like this—much of its feasibility had to rely on recycling decades-old components, keeping costs manageable and taking advantage of tried-and-tested hardware. "We weren't trying to push the limits in any other way except to prove you could dampen the sonic boom," Dave Richardson, program director for the X-59 at Lockheed Martin, told me last year during a video interview. "There is no radical technology in the airplane itself. It really is just the shape of the aircraft."

New skin, old guts

The X-59's engine is a prime example of the team's approach to mixing old and new. The General Electric F414-GE-100 inside the X-59 is the same power plant used in the U.S. Navy's F/A-18 Super Hornet fighter jet. Providing 22,000 pounds of thrust, this engine allows the X-59 to cruise at Mach 1.4—roughly 925 mph—at 55,000 feet. The engine has already logged countless flight hours under demanding conditions, which translates into reliability for the X-59's ambitious test flights.

By repurposing the F414-GE-100 engine and many other key components "stolen" from other airplanes, the team not only cut down on development time but also kept the typical budget overruns that plague these kinds of projects at bay. Using well-tested parts that have logged millions of hours of flight not only avoids testing new parts but also drastically reduce the risk of failure, as these components have already proven their reliability under a wide range of operational stresses. This approach also decreases the overall complexity of the

design and reduces the number of potential breaking points, ultimately improving the overall safety and efficiency of the X-59.

The landing gear of NASA's X-59 is sourced from the [F-16](#) Fighting Falcon. Like the F-18 for the Navy, this has been the main battle horse for the US Air Force and many other air forces around the world for decades. The landing gear was chosen not only because it is made by Lockheed Martin—the parent company of Skunk Works—but also because its robust design is specifically suited for handling the stresses of military operations. Designed to withstand repeated, high-impact landings on shorter runways, the designers thought it would be the ideal choice for the X-59's profile, making it an optimal choice for this experimental aircraft.

The propulsion system also incorporates the engine inlet from the U-2 spy plane, another legendary plane designed by the Skunk Works team. The U-2, renowned for its high-altitude reconnaissance missions, has a well-proven design that effectively manages airflow at extreme altitudes, where the atmosphere is much thinner than what you find in the typical cruising altitude of a regular jet. Integrating this part into the X-59 allowed engineers to ensure efficient engine performance without having to create a completely new inlet system. And once again, shaving a lot of dollars from the overall budget. The U-2's engine inlet is engineered to fly at 70,000 feet, a capability that directly aligns with the X-59's need for efficient high-altitude flight. Its integration ensures stable airflow to the engine, crucial for maintaining the consistent power needed for supersonic speeds.

The canopy of the X-59 is taken from the Northrop T-38 trainer aircraft, which has been used for decades to train pilots. NASA's new silent supersonic aircraft doesn't have a front cockpit, instead [relying on a digital cockpit that uses displays and cameras](#), which is also the only new tech in the plane after its weird dart-looking shape. But it *does* have a canopy over the pilot's seat. The T-38 canopy is designed to offer good visibility and withstand high-speed airflow, which makes it an effective solution for the X-59's needs. This design ensures the pilot has an unobstructed view while also benefiting from a proven aerodynamic shape that integrates seamlessly with the aircraft's long fuselage.

The control stick and rudder pedals are taken from the famous F-117 stealth fighter that came into the public eye during the first Gulf War. Known for its

uniquely hard-to-handle flight characteristics, a byproduct of its triangular polygonal fuselage and wings, the F-117's control system has proven its effectiveness in high-stress environments. By reusing these, the engineers ensured that the X-59 would benefit from a reliable and well-understood pilot interface. The familiarity of these old control systems, especially in an airplane that may be as difficult to handle as the X-59, contributes to the overall dependability of a new airplane because the pilots will have an easier time adjusting to the feeling and handling of this supersonic beast.

Start your engines

There are many other minor reused parts that [neither NASA nor Lockheed Martin have disclosed](#), but all of them played a critical role in staying within the limited budget. They played the role of pre-made Lego blocks that needed to be seamlessly inserted into the X-59's wild form.

The legendary advanced aerospace design group began working on what would eventually become the X-59 back in 2013. Early iterations focused on balancing the aircraft's weight distribution to optimize supersonic performance. "The heavy parts of the plane needed to be as far back as possible. We put nothing out in the front," Richardson explained to me during our interview. This approach resulted in the plane's strikingly long nose and sleek design, carefully tailored to manage shockwaves as they travel along the body of the aircraft.

With this engine test and a first flight expected early next year, the X-59 Quesst mission is poised to tackle one of aviation's biggest challenges: making supersonic flight over land feasible again. Its success could pave the way for a new generation of commercial airliners that travel faster than sound without disturbing those below. This kind of leap is even more interesting when you consider how the genius designers used off-the-shelf parts wherever possible, managing to create an experimental aircraft that leverages the reliability of familiar systems while still pushing the boundaries of aerodynamics and noise reduction.

"We have a small step that could lead to a big transformation in air transport," Richardson told me. After the aircraft takes off and the pilots assess that it's fully

ready to begin work, the real tests will start and the plane will be flying for months over various U.S. communities while ground teams measure both the physical sound of the reduced sonic thump and the public's reaction to it.

After their study is complete, they will provide data for regulatory bodies in order for them to amend flight laws in the United States and around the world, effectively lifting the current ban on commercial supersonic flights over land. As Paul Dees, deputy propulsion lead for the X-59 at NASA, says in the NASA press release announcing the milestone: "The success of these runs is just the first note of a symphony; we still have many notes to play until the flight." Hopefully, a symphony that will end in thundering fanfare to celebrate the beginning of a new commercial silent supersonic flight era as well.

Supersonic Passenger Flight Returns After Two Decades

[For the first time in over 20 years, a civilian aircraft has surpassed the sound barrier.](#) The rocket-powered Mk-II Aurora, developed by Dawn Aerospace, reached Mach 1.1 during a test flight. This milestone marks a major step forward in the revival of supersonic travel.

Breaking the Supersonic Silence



Supersonic Passenger Flight Returns After Two Decades

Supersonic Passenger Flight Returns After Two Decades© Provided by Ever-Growing

The Mk-II Aurora's achievement comes after a long hiatus in civilian supersonic aviation. The Concorde, which conducted its final commercial flight on October 24, 2003, was the last passenger aircraft to operate at supersonic speeds. The experimental Mk-II Aurora broke that silence on November 12, 2024, during a test flight at over 15.5 miles above the Earth's surface. Using a rocket engine with a thrust-to-weight ratio 20 times greater than conventional jet engines, the Mk-II demonstrated its advanced capabilities.

Record-Breaking Performance

In addition to breaking the sound barrier, the Mk-II Aurora set a new record for climbing to an altitude of 12.4 miles in just 118.6 seconds. This surpassed a record previously held by a modified F-15 aircraft since the 1970s. The test flight, conducted near Mount Cook in New Zealand, showcased the Mk-II's groundbreaking efficiency and speed. The Mk-II is also notable for being the first supersonic aircraft entirely designed and built in New Zealand.

Small Scale, Big Ambitions

While the Mk-II Aurora is an impressive technical achievement, it is far from the scale of the Concorde. With a wingspan of just 13 feet and a dry weight of 48.5 pounds, the Aurora is still an experimental aircraft. Dawn Aerospace aims for future versions to fly at Mach 3.5, potentially carrying payloads to the edge of space at 62 miles above Earth. These ambitions could pave the way for advancements in satellite deployment and the revival of civilian supersonic flight.

The Road Ahead for Supersonic Aviation

Supersonic travel for civilian purposes remains rare and challenging, particularly due to issues like sonic booms and fuel efficiency. Companies and governments are exploring solutions, such as the NASA-Lockheed X-59 project, which aims to produce a quieter sonic boom. These efforts reflect growing interest in commercializing supersonic technology, despite setbacks like the recent bankruptcy of Exosonic. The future of supersonic passenger aviation will depend on overcoming these hurdles.

The return of civilian supersonic flight raises fascinating possibilities for the future of travel and technology.

Airplane Innovations You Never Knew Shaped Aviation History

Aviation has seen remarkable advancements over the years, transforming how we travel and experience the skies. From cutting-edge safety features to luxurious comforts, these innovations have made flying more efficient, safer, and more enjoyable. In this article, we'll explore the most surprising airplane innovations in aviation history that have truly changed the game.



Jet Engines

Jet engines increased the speed and efficiency of air travel, making long-haul flights more feasible. Unlike piston engines, jet engines provide a higher power-to-weight ratio, allowing aircraft to travel faster and higher. This innovation enabled the rapid expansion of global air travel networks.

Fly-by-Wire Technology

Fly-by-wire technology replaced traditional manual flight controls with electronic systems, enhancing control and safety. This innovation allows for more precise maneuvering, reduces the risk of mechanical failure, and integrates seamlessly with autopilot and other advanced avionics.



Composite Materials

The use of composite materials made aircraft lighter and more fuel-efficient. These materials, such as carbon fiber-reinforced polymers, are stronger and lighter than traditional aluminum. The Boeing 787 Dreamliner and Airbus A350 are prime examples, utilizing composites to achieve significant weight savings and fuel efficiency.

Winglets

Winglets are vertical extensions on the tips of airplane wings that improve aerodynamics and fuel efficiency. By reducing drag, winglets help aircraft save fuel and increase range. They also contribute to smoother flight by reducing turbulence.

Pressurized Cabins

Pressurized cabins enabled high-altitude flying with greater passenger comfort. This innovation allowed commercial jets to fly above weather disturbances and achieve faster, more fuel-efficient travel. Passengers experience a more stable and comfortable flight environment.

In-Flight Entertainment Systems

In-flight entertainment systems enhanced passenger experience by offering movies, games, music, and more. These systems, evolving from overhead screens to personal touchscreens, help passengers pass the time during long flights and improve overall satisfaction.

Glass Cockpits

Glass cockpits replaced analog dials with digital displays, improving pilot situational awareness. These advanced displays integrate flight information, navigation, and system status into intuitive screens, reducing pilot workload and enhancing safety.



Weather Radar Systems

Weather radar systems allow pilots to detect and avoid severe weather, improving safety and comfort. These systems provide real-time data on storms, turbulence, and wind patterns, helping pilots make informed decisions during flights.



Noise-Reducing Engine Technology

Noise-reducing engine technology made flights quieter and more environmentally friendly. Innovations like high-bypass turbofans and chevron nozzles reduce noise pollution, benefiting both passengers and communities near airports.

Airbus A380 Double-Decker Design

The Airbus A380's double-decker design significantly increased passenger capacity. With its two full-length passenger decks, the A380 can carry more passengers than any other commercial aircraft, making it ideal for high-density routes.



Boeing 787 Dreamliner's Composite Structure

The Boeing 787 Dreamliner's composite structure reduced weight and increased fuel efficiency. Using a high percentage of composite materials, the Dreamliner achieves greater fuel savings and lower maintenance costs, representing a leap forward in aircraft design.



In-Flight Wi-Fi

In-flight Wi-Fi keeps passengers connected even at 35,000 feet. This innovation allows travelers to stay productive, entertained, and in touch with loved ones, significantly enhancing the in-flight experience.

NextGen Air Traffic Control System

The NextGen air traffic control system improved efficiency and reduced delays. By using satellite-based navigation and advanced communication technologies, NextGen optimizes air traffic flow, enhances safety, and minimizes environmental impact.

Variable Camber Wings

Variable camber wings adjust wing shape for better performance in different flight phases. This innovation allows for optimal lift and drag characteristics during takeoff, cruising, and landing, improving overall efficiency and handling.

Raked Wingtips

Raked wingtips further improved aerodynamics and fuel efficiency. By extending the wingtip and angling it backward, this design reduces drag and enhances the aircraft's performance, contributing to fuel savings and longer ranges.

The Science Behind Fighter Jet Afterburners Explained



F-22 Raptor© Mike Cassidy/Getty Images

Watching a fighter jet take off is a beautiful sight. Anyone who hasn't been to an air show should really try to see one of the [incredible air shows that captivate aviation enthusiasts worldwide](#) at least once. Once you get past the roaring crescendo of its engines revving up, seeing a fighter jet race down the runway before lifting off the ground and soaring through the sky with a trail of fire erupting from its tail is a truly enlightening sight. It shows you just how far technology has advanced since the Wright Brothers.

Take away the [incredible features in modern fighter jets](#) like the hidden weaponry and [science behind stealth capabilities](#) and you're still left with a vehicle capable

of amazing feats unimaginable more than half a century ago. The afterburner that gets the jet off the ground and up to sound breaking speeds alone is a technological marvel. Most people take it for granted, not realizing the science that goes into moving a jet at supersonic speeds.

A plane can get off the ground without an afterburner -- passenger planes do it all the time. But modern-day fighter jets would be hard pressed to take off without an afterburner. Fighter jets are considerably heavier than prop planes from World War II between the materials used to manufacture them and their armament. They need to stay small and fast, so even the engines on a Boeing 747 wouldn't work. The afterburner gives jets that little extra boost to takeoff.

Read more: [The 10 Most Iconic Airplanes In Aviation History, Ranked](#)

How Afterburners Work



Jet engine© Dizfoto/Getty Images

Afterburners are used on modern day fighter jets to help give them enough thrust to takeoff , specifically on an aircraft carrier, as well as to fly faster than the speed of sound when they need to get somewhere quick. When the pilot engages the afterburner, it creates a reaction that erupts enough force to propel the jet forward. The fuel (usually kerosene) enters the engine through hundreds of tiny holes and is combined with the air already being sucked in. A device that creates an electric spark ignites the fuel, forcing it to expand the oxygen in the air stream. The heat generated from the air and fuel shoots out of the exhaust, creating the pilot's desired thrust.

The engine is designed in such a way that the flames from the exploding fuel don't touch its walls, otherwise it could burn through and damage it. 3,000 degrees Fahrenheit has no problem tearing through most materials. Luckily, the air is colder at higher altitudes, which adds a layer of protection.

When the afterburner isn't engaged and the jet is flying at cruising speed, the engine acts as a typical turbojet. It might add an extra 50% of thrust, but pilots have to use the afterburner sparingly or risk running out of fuel too fast.

Non-Fighter Jets That Use Afterburners

Fat Albert using its afterburners© Michael Hare/Shutterstock

Typically, it's only fighter jets that utilize afterburners since few other aircrafts fly at supersonic speeds. Not only are there a couple non-fighter jets that make use of afterburners, there's one propellor plane that uses them too. That plane is called Fat Albert. It's the modified C-130T Hercules that follows around the elite Blue Angels demonstration team. Unlike most planes equipped with afterburners that use them to fly at blazing speeds, Fat Albert uses them for takeoff only. The fancy-looking cargo plane is primarily used to haul crew, tools, and support equipment for the team's F/A-18 Hornets, but it does its own little performance during air shows. A C-130 that uses jet-assisted take-off (JATO) rockets is quite the sight for most crowds.

The Concorde is another aircraft that made use of afterburners even though it wasn't a fighter jet. The Concorde was a one-of-a-kind supersonic passenger plane that flew Mach 2.04, or 1,354 mph, bringing travelers from New York to London in just under three hours time. By comparison, it takes the average passenger airline around seven hours to make the same flight today. Unfortunately, after a Concorde flight crashed in 2000, the airline retired the plane in 2003, putting an end to supersonic flights for civilians.

Since the Navy retired the C-130T in 2019 and upgraded Fat Albert to a C-130J in 2021, a version of the plane without its JATO rockets, there is no longer an aircraft with afterburners that isn't a fighter jet.

The Future Of Afterburners



F-16 with its afterburner engaged© Flight Video and Photo/Shutterstock

Afterburners are an essential piece of fighter jets and will continue to be used well into the 21st century. However, they're not without their drawbacks. Stealth

has become a vital component for fighter jets. Getting in and out of enemy territory without being detected is an invaluable feature that can't be understated. Unfortunately, when pilots engage the afterburner, they're exposed to radar waves and infrared detection devices. Newer jets like the F-22 Raptor can cruise faster than the speed of sound without engaging the afterburner, which is helpful but not perfect. As of now, there's no way to hide the immense heat erupting from the rear of a plane.

Besides stealth, jets always have a need to go faster, farther, and use less fuel. Small start-ups like [Destinus are developing hydrogen-powered afterburners](#) that can aid in those endeavors. Its afterburner is only capable of reaching roughly 150 mph, a far cry from its supersonic and eventual hypersonic goal. If Destinus manages to create a hydrogen-powered afterburner at the very least keep pace with their kerosene-power counterparts, it's only a matter of time before militaries around the world integrate that technology into their fighter jets.

What Type Of Fan Is In A Jet Engine And How Does It Work?



A turbofan engine with the fan clearly visible© Paulsveda/Getty Images

If you ask anyone working in the aviation industry what they think the most important component of modern-day planes is, chances are the vast majority may tell you that it is the jet engine. Also known as gas turbines, this modern-day engineering marvel played a significant role in transforming airplanes into one of the most commonly used forms of transportation known to man. [Some of these engines](#) have had a lasting impact on the aviation industry as a whole.

Most jet engines of today look nearly identical, with only slight differences in external design helping aviation enthusiasts differentiate between different models. However, a feature common to all these engines is the single, massive fan that covers almost the entire circumference of the engine. As the only visible

component of modern-day jet engines and perhaps the most identifiable feature of today's jet engines, it is nigh impossible to miss this significant piece of hardware.

While it is easy for laypeople to mistake these large fans as a simple, not-too-essential part of jet engines, the truth is that these fans might be the most significant upgrade the jet engines have received since these engines burst onto the scene in the mid-60s. In fact, these fans — which go by the name "turbofans" is the very reason modern-day jet engines are called turbofan engines. So, if you're here for a quick answer to what type of fan is used in jet engines, the quick answer would be that it is a turbofan engine, which is a portmanteau of the word "turbo" and "fan"

Read more: [14 Best Fighter Planes And Jets Of All Time](#)

The Role Of The Fan In Turbofan Engines



The vast majority of jet engines in operation today are turbofan engines, with these machines also used on [several fighter jets](#). As mentioned earlier, these engines get the "fan" part of their name from the large fan that dominates its front. This fan exists for several reasons, the most important of which is to maximize the amount of air that can be sucked into the combustion chamber of the engine. A direct result of this design is that the engine is able to generate greater amounts of thrust, because of the larger volume of air being directed into the engine.

A unique design feature of turbofan engines is something called the bypass duct which is located around the engines. Besides directing a larger volume of air into the engine's combustion chamber, the fan is also designed to direct colossal volumes of air into those bypass ducts. The bypass duct is wider at the front and tapers towards the rear, a design change that compresses this bypassed air and generates additional thrust in the process.

As a result of this, turbofan engines generate a significant amount of their power through the bypassed air that goes through the bypass ducts around the engines, without the need for additional fuel. These design advantages allow turbofan engines to generate thrust more efficiently compared to older turbojet engines, giving them an edge over [turbojet engines](#) as far as fuel efficiency is concerned. These design choices, combined with several decades of refinements to the engine design have also made turbofan engines a lot quieter, further boosting its popularity.

Which Jets Use The GE9X Engine And How Powerful Is It?



A Boeing 777X with a GE9X engine© John Keeble/Getty Images

The GE9X turbofan is already shattering records as the largest and most sophisticated turbofan ever built. With a record-breaking thrust of 134,300 pounds and an equally impressive core speed of 11,119 revolutions per minute (RPM), the engine stands out as one of the most significant leaps in aviation history. However, given its size and sheer power output, the question now arises: Which jets have the engine under their wings?

When [General Electric Company](#) (GE Aerospace) first announced the GE9X in February 2012, it discussed a more robust successor to its already powerful GE90 turbofan. The engine promised aerodynamic efficiency, a higher bypass ratio, and a better engine pressure ratio while also being built from advanced, lighter, yet

more impact-resistant materials. From lower NO_x, CO₂, and noise emissions to better fuel consumption, the aircraft engine supplier was looking to improve the GE90 in every way possible and all in time to put the engine on the next series of [Boeing's 777X jetliners](#).

GE had already worked closely with Boeing on several commercial aircraft, supplying engines for the 787, 777, 767, and 747. With the next installment of the 777 series, the 777X -- the world's largest twin-engine passenger plane -- GE was clearly out to make something special.

Read more: [14 Best Fighter Planes And Jets Of All Time](#)

Matching The Might Of The Boeing 777X



Staff sit in the shade under a Boeing 777X© John Keeble/Getty Images

The Boeing 777X has three variants: the 777-9, 777-8, and 777-8 Freighter. If GE's goal with the GE9X was to match the might of these aircraft, then they have

succeeded. The GE9X is a dual-rotor high-bypass turbofan with 16 fourth-generation composite blades housed in a composite case. Its length and diameter are 220 inches and 121 inches, respectively. The engine weighs 22,000 pounds, which is heavier than the GE90, despite having fewer fan blades (six fewer blades than the GE90) and using lighter epoxy resin and ceramic matrix composite (CMC) materials in its build.

The GE9X is, by no doubt, one of [the most powerful aircraft engines](#) to date. Its first ground test was in April 2016, and its first flight was in March 2018 on a Boeing 747-400. In January 2020, GE and Boeing finally took a 777-9 equipped with two GE9X engines on its maiden flight. Currently, GE will be the only engine supplier for the Boeing 777X, thus making the GE9X exclusively for it. In November 2023 alone, Emirates had 460 orders of GE9X engines, with Singapore placing an additional 22 orders just a year before.

Ramjet Vs. Scramjet: What's The Difference Between These Jet Engines?



Brahmos missiles mounted on a truck bed© Pallava Bagla/Getty Images

A jet engine is any engine that can propel an aircraft of some kind via rearward expulsion of a jet of fluid, typically a hot exhaust gas that the engine generates by drawing in fuel from the atmosphere. Most modern jet engines seen by the general public use a gas turbine — also known as a gasifier, gas producer, core, or gas generator — to convert energy generated from the combustion of a hydrocarbon fuel into mechanical energy through a high-temperature, high-pressure airstream. The propulsor then takes that energy and harnesses it into thrust that pushes the aircraft forward.

However, not all aircraft use this type of engine: There are also [ramjet and scramjet engines](#), which utilize different methods of generating energy to propel the aircraft forward. **Some ramjet and scramjet engines can even break the sound barrier, allowing aircraft to move at a hypersonic speed thanks to the engine's unique architecture.** Let's look at the differences between ramjet and scramjet engines.

What Is A Ramjet Engine?



a missile powered by a ramjet engine© Bettmann/Getty Images

Ramjet engines are a type of experimental engine designed to have no moving parts. These types of engines lack the traditional gas turbine that helps generate combustion energy and forward thrust as would typically be present in a modern jet engine. Instead, ramjet engines rely on the immense air pressure generated by supersonic airstreams to propel the aircraft forward.

Ramjet engines provide a simple and lightweight propulsion system designed for supersonic flight. They draw in large amounts of air through the

engine inlet using the forward motion of the aircraft. As the air passes into the inlet, it slows down, but the dynamic pressure from the velocity turns into high static pressure for combustion. The fuel-air mixture is burned, and at the exit of the inlet, the air is at a significantly higher pressure than free stream.

However, ramjet engines have a significant difference in operations from a standard turbine engine. Since there is no compressor or turbine, the engine has no way to draw air into it besides the forward motion of the aircraft. In a standard jet engine, the turbine draws the air in to create the fuel-air combustion mixture. Without the turbine to draw air in, the ramjet engine requires a consistent, high-speed, forward motion to create the combustion of fuel and air. At zero speeds, a ramjet engine is completely redundant. An aircraft must move at a speed of at least Mach 3 for a ramjet engine to work correctly.

What Is A Scramjet Engine?

The scramjet — or "supersonic combustion ramjet" — engine is an innovation on the original ramjet engine design that changes the internal combustion chamber to remove the shock cones. In a traditional ramjet, the air entering the engine inlet is slowed by the shock cones which narrow the passageway for air pressure, and in turn, increase the jet's speed. However, scramjets use shockwaves produced by the engine's ignition source to slow the air entering the inlet for combustion instead.

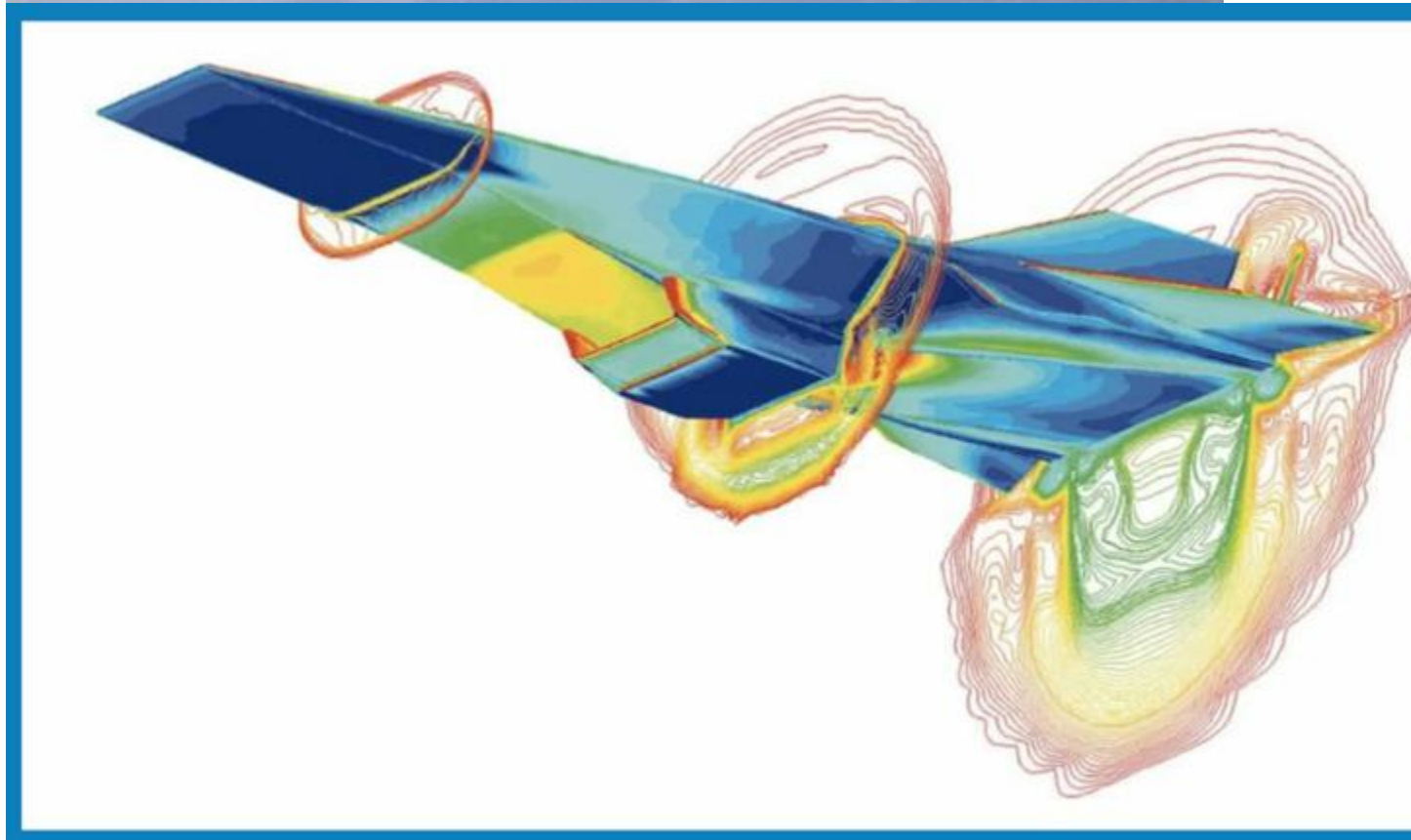
Additionally, the [scramjet engine](#) is able to perform engine combustion at supersonic speeds, while the traditional ramjet must slow the air entering the engine inlet to subsonic speeds. This change allows scramjet engines to operate at higher speeds than ramjet ones. Scramjets can operate at Mach 6 and higher, with some tests reaching as high as Mach 10 cruising speeds when using these engines. However, like regular ramjet engines, their functionality requires a high speed to even begin operation. In testing, aircraft with scramjet engines must be lifted to altitude by another aircraft and then propelled to an operating speed by another engine before they can engage.

What Are Ramjet/scramjet Engines Used For?



Brahmos scramjet missile tip© Daniel Berehulak/Getty Images

In the current day, the practical application of ramjet/scramjet engines is somewhat limited. **The most prominent use of the technology is in military weaponry; specifically missiles such as the BrahMos missile.** Using a ramjet engine on a missile allows for a quick and efficient payload delivery. Ramjets and scramjets could also be used in high-speed military unmanned aerial vehicles, making them more effective and efficient in reconnaissance and other operations. There are also experimental applications of ramjet and scramjet technology in the fields of air travel and space exploration. The use of these engines in air travel could significantly change commercial hypersonic flights. Currently, the only such [hypersonic airline that existed was the Concorde](#). The [hypersonic passenger plane](#) was decommissioned more than two decades ago, and utilized turbojets at the time. However, future projects could utilize ramjets or scramjets in passenger air travel. Ramjets and scramjets could also be used in unmanned aircraft in civilian spheres, such as deliveries, assuming the technology can be commercialized on a wider scale.



US scientists master control of hypersonic jet engine with light-based tech © Provided by Interesting Engineering

A new NASA-funded study has revealed for the first time that the airflow in supersonic combustor jet engines can be controlled by an optical sensor.

The finding can lead to more efficient stabilization of hypersonic jet aircraft, according to the study carried out by the researchers at the University of Virginia, School of Engineering and Applied Science.

The research allows operators to control airflow at the speed of light when a 'shock train' occurs. A shock train is a condition that precedes engine failure within a scramjet engine.

The earlier approach relied on monitoring airflow through a supersonic combustor jet engine using a pressure sensor, while the new breakthrough allows doing the same using an optical sensor.

NASA-funded research

[NASA's](#) hypersonic jet plane 'Hyper-X set a record for flying faster than any other aircraft in 2004.

The final X-43A unmanned prototype had set the record in the last test held in November 2004, by clocking a world-record speed of Mach 10, which is 10 times the speed of sound. This type of speed had only been achieved by a rocket previously.

This breakthrough had led to a major shift in jet development – by allowing the leap from ramjets to more efficient scramjets. Although the hypersonic proof of concept was successful, the main challenge was achieving engine control, because the tech relied on old sensor approaches.

However, this new breakthrough by UVA brings some hope for the future X-plane series which can travel at hypersonic speeds.

Apart from showing that airflow in supersonic combustor jet engines can be controlled by an optical sensor, the NASA-funded study also achieved adaptive control of a scramjet engine.

According to the researchers, adaptive engine control systems respond to changes in dynamics to keep the system's overall performance optimal.

Professor Christopher Goyne, director of the UVA Aerospace Research Laboratory, said that the country's aerospace priorities since the 1960s has been to build single-stage-to-orbit aircraft that fly into space from horizontal takeoff like a traditional aircraft and land on the ground like a traditional aircraft.

"Currently, the most state-of-the-art craft is the SpaceX Starship. It has two stages, with vertical launch and landing. But to optimize safety, convenience and reusability, the aerospace community would like to build something more like a 737," Goyne [said](#).

Optical sensors could be crucial for hypersonic aircraft

"It seemed logical to us that if an aircraft operates at hypersonic speeds of Mach 5 and higher, that it might be preferable to embed sensors that work closer to the speed of light than the speed of sound," Goyne said.

UVA has several supersonic wind tunnels that can simulate engine conditions for a hypersonic vehicle traveling at five times the speed of sound.

Goyne explained that "scramjets," short for supersonic combustion ramjets, build on ramjet technology that has been in common use for years.

Currently, like ramjets, scramjet engines need a step-up to get them to a speed where they can intake enough oxygen to operate.

The latest [innovation](#) is a dual-mode scramjet combustor, which was the type of engine the UVA-led project tested. The dual engine starts in ramjet mode at lower Mach numbers, then shifts into receiving full supersonic airflow in the combustion chamber at speeds exceeding Mach 5.

No longer limited to information obtained at the engine's walls, as pressure sensors are, the optical sensor can identify subtle changes both inside the engine and within the flow path.

The tool analyzes the amount of light emitted by a source — in this case, the reacting gases within the scramjet combustor — as well as other factors, such as the flame's location and spectral content.

First proof of adaptive control

According to a release by the UVA, the wind tunnel demonstration showed that the engine control can be both predictive and adaptive, smoothly transitioning between scramjet and ramjet functioning.

The wind tunnel test, in fact, was the world's first proof that adaptive control in these types of dual-function engines can be achieved with optical sensors, the release stated.

The team [believes](#) optical sensors may be a component of the future plane-like travel to space and back.

This could help in making an all-in-one aircraft that could glide back to Earth like the space shuttles once did.

"I think it's possible, yeah," Goyne said. "While the commercial space industry has been able to lower costs through some reusability, they haven't yet captured the aircraft-like operations. Our findings could potentially build on the storied history of Hyper-X and make its space access safer than current rocket-based technology."

Biggest Differences Between F-16 & F-18 Fighter Jets



F-18 and F-16 © Pawel Bednarski 303 & Mostafa Ajawi/Shutterstock

The F-16 Fighting Falcon is the world's most popular fighter jet, with over 2,100 serving active roles in various air forces. On the other hand, the F-18 Hornet (or Super Hornet for the later variants) is the fourth most popular, with 836 airframes between Australia, Canada, Finland, Kuwait, Malaysia, Spain, Switzerland, and, of course, the U.S.

Despite being operated globally by many governments' militaries, most of us would equate both jets with American air power. But why did the U.S. need to make two different fighter aircraft types? Since both planes are fighter jets, why not just use one plane and get rid of the other? The answer is that they're quite different.

So, let's compare the F-16 and the F-18, and see why America needs both planes to retain its strategic edge. Aside from the physical differences between the two planes, we'll also look at their mission profiles to see why both jets are needed in the U.S. military's arsenal. **What Is The F-16 Fighting Falcon?**



F-16 Fighting Falcon© Viper-zero/Getty

The F-16 Fighting Falcon is a single-engine, single-seat multi-role fighter first manufactured by General Dynamics, but it has since been taken over by Lockheed Martin. The F-16 was envisioned as a low-end fighter (cheaper, more affordable) to the Air Force's high-end F-15 Eagle air superiority fighter.

While it was initially designed as an air-to-air fighter, it has since been modified to accomplish other missions. The Air Force first received the F-16 in 1978, meaning these jets [will hit 50 in just a few years](#). However, they're [still in use today](#) and will likely see combat against Russia when Ukraine gets them this year. Other countries, like Turkey and the Philippines, are also considering purchasing these aircraft, especially as Lockheed has kept them updated for modern battlefields with the F-16 Block 70/72 Viper model. There are also two-seat

variants of the F-16, namely the F-16B and the F-16D, , which are primarily used for training but can still be employed in combat missions.

The F-16 design is so successful that it spawned another variant, the Mitsubishi F-2. This aircraft was made by Mitsubishi Heavy Industries, the same company that built the Mitsubishi A6M Zero, one of [the most legendary naval aircraft ever](#), in partnership with Lockheed Martin. General Dynamics also pitched F-16-based contenders for other fighter programs, including the Vought Model 1600 (in partnership with Vought and competed against the Northrop-McDonnell Douglas YF-17-based Model 267, which became the F/A-18) for the U.S. Navy's carrier-based fighter program and the F-16XL to compete against the F-15E

Strike Eagle for the Air Force's Enhanced Tactical Fighter program. **What Is The F/A-18 Hornet And Super Hornet?**



F/A-18 flying© Andy_oxley/Getty

The F/A-18 Hornet and newer Super Hornet variants were built from the ground up as all-weather fighter and attack aircraft, hence the F/A (F for fighter and A for

attack aircraft) designation. And while other countries' air forces fly the F/A-18 from land, it was primarily built for the U.S. Navy as a carrier-borne aircraft.

Nevertheless, it was the U.S. Marine Corps that was the first to receive this aircraft in 1983, and the Navy got it the following year. The F/A-18 also came in several flavors—The F/A-18A and F/A-18C are single-seat variants, while the F/A-18B and F/A-18D had two seats. The B model was primarily used for training, while the A, C, and D models were used for combat and reconnaissance missions.

In 1999, the latest iteration of the Hornet arrived on the scene with the F/A-18E/F Super Hornets. These models were so good that the U.S. Navy ordered more of these jets 25 years later in 2024. Aside from these attack aircraft, the F/A-18 also spawned an electronic warfare version, [called the EA-18 Growler](#).

What Are The Physical Differences Between The F-16 And The F/A-18?



F-16 vs F/A-18 © VanderWolf Images/Shutterstock & Dynasoar/Getty

The most obvious difference between the F-16 and the F/A-18 is the number of engines. The F-16 Fighting Falcon has a single engine with its intake sitting prominently under its belly. On the other hand, the F/A-18 has two engines with the intakes on either side of the rear half of the fuselage.

Aside from this, the F-16 only has one large tail while the F/A-18 has a twin tail configuration. One advantage of the F/A-18's two tails is that it can be shorter compared to jets with one single tail. Since space is limited on aircraft carriers, these smaller tails make it easier to move and store jets below deck. Furthermore, it helps reduce weight and complexity, as the aircraft maker doesn't need to add a folding mechanism for the tail.

One more thing you'll notice about the F/A-18 is its extra beefy landing gears and thick arresting hook. The F/A-18 is built for carrier operations, so it needs to be able to stop on the dime. Even though aircraft carriers are [some of the largest ships](#) in the world, they're still pretty short at just around 300 meters long. So, the Hornet (and the Super Hornet) requires thick legs to ensure that they can withstand the heavy landings these jets make at sea, especially while a ship is being tossed about by the ocean.

What Missions Does The F-16 Fly?



F-16 mission© Usaf/Getty

Although the F-16 started as an air-to-air fighter, its capability has grown and can do several other things now. The U.S. Air Force calls the F-16 Fighting Falcon a compact, multi-role fighter aircraft, which gives us a clue on how versatile this jet is. This plane has been tested in actual combat and has faced air-to-air battles and taken air-to-ground missions, allowing it to do almost anything.

Some of the things that the F-16 can do include "Wild Weasel" SEAD (or Suppression of Enemy Air Defenses), close air support, forward air control, and counter-air missions. F-16s can also be configured to carry the B61 Nuclear Gravity bomb, allowing the aircraft to conduct tactical nuclear strikes inside enemy territory.

The F-16 can also be refueled from Air Force tanker aircraft, allowing it to extend its range as needed. However, it takes on fuel via a boom, so it cannot accept fuel from U.S. Navy aircraft that only use the hose-and-drogue method to refuel other planes.

What Can The F/A-18 Hornet Do?



F/A-18 taking off© Justin Sullivan/Getty

Like the F-16, the F/A-18 is a multi-role fighter that can do a lot. The F/A-18B model is primarily used for training pilots to operate the jet, but the F/A-18A, C, and D, are combat-focused jets that can take on air-to-ground attack roles,

provide close air support, suppress enemy air defense, and strike naval and maritime targets.

They're also used for air superiority missions, as fighter escorts, and to serve as fleet air defense protect the Carrier Strike Group. Other missions that the F/A-18 can accomplish include airborne forward air controller and reconnaissance missions. It's also the aircraft that the Navy uses for aerial refueling via buddy stores, allowing other Navy aircraft to take off with heavier loads (i.e., carry more weapons) and then top-up tanks once airborne to extend mission range.

Of course, we can't forget the EA-18G Growler, which is basically an F/A-18F Super Hornet reconfigured to deliver massive electronic interference to enemy radar screens. This aircraft ensures that the adversaries cannot see other U.S. aircraft coming into attack, helping them avoid detection and giving their pilots a greater chance in accomplishing their missions.

The F/A-18 Hornet and Super Hornet aircraft were more suitable for the Navy's need, like their twin-engine configuration and smaller intakes (which meant less chance of sucking up an inattentive deck crew), that's why the Navy didn't choose the F-16 (or its carrier-based variant). Despite the efforts to create a unified fighter jet with the F-35, the needs of the various services (Air Force, Navy, and Marine Corps) mean that it's highly difficult to create a single plane that can meet everyone's requirements — that's why [the Lightning II variants](#) have little in common.

World's first hypersonic jet that can travel from London to New York in one hour set to take test flight



A New Era of High-Speed Travel

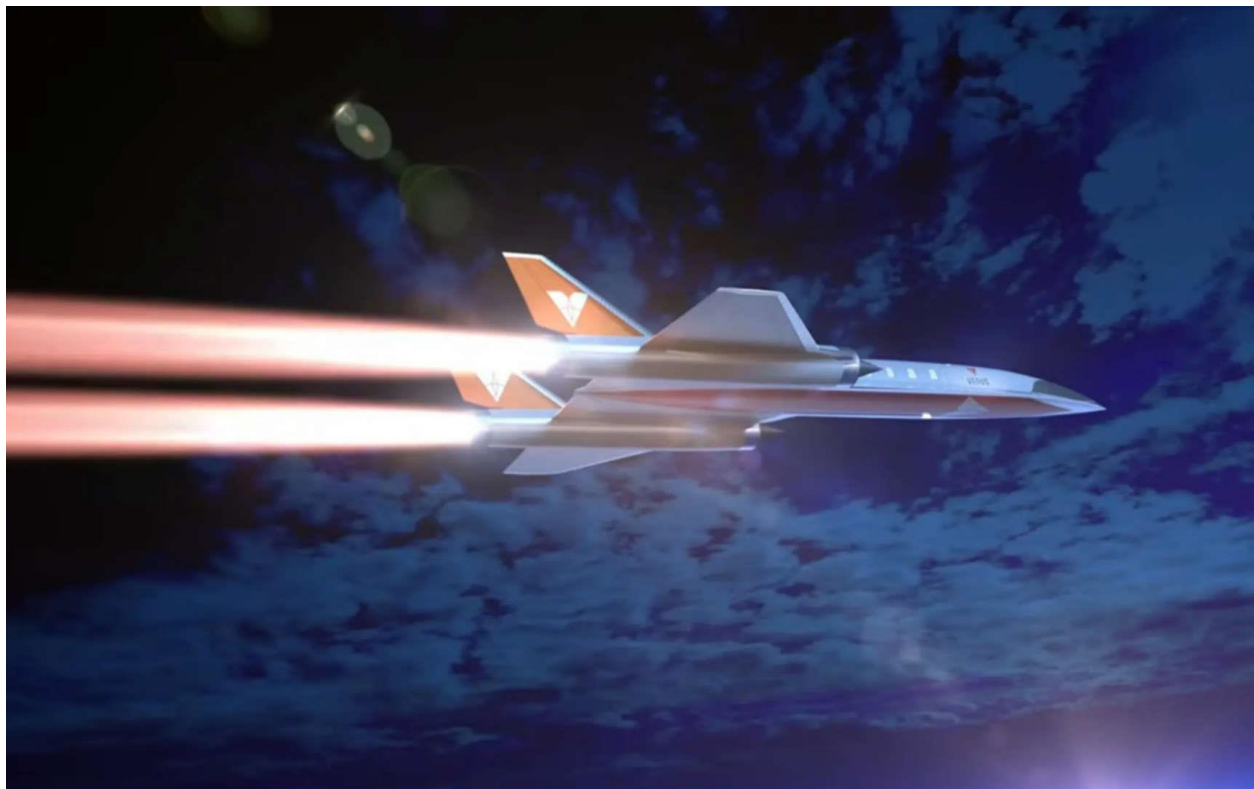
The journey from New York to London typically takes around seven hours on a conventional passenger aircraft. Even Concorde, the legendary supersonic aircraft, managed the route in just under three hours. However, with the introduction of the [hypersonic Stargazer](#), that travel time could be slashed to a mere 60 minutes.

Hypersonic flight refers to any speed above Mach 5 (approximately 3,800 mph). The Venus Aerospace jet will not only be much faster than any commercial plane to date but will also fly at significantly higher altitudes. Passengers aboard the Stargazer will reach up to 110,000 feet, more than twice the cruising altitude of standard passenger jets, offering spectacular views of the curvature of the Earth.

The Technology Behind Hypersonic Speed

At the heart of this hypersonic revolution is the Venus Detonation Ramjet 2000 lb Thrust Engine (VDR2). The engine uses a combination of traditional jet propulsion for takeoff and rocket propulsion at higher altitudes. This dual system allows the aircraft to reach speeds of Mach 6, or approximately 3,600 miles per hour.

Dr. Andrew Duggleby, co-founder of [Venus Aerospace](#), expressed excitement at the unveiling of the VDR2 engine, [stating](#), "This engine makes the hypersonic economy a reality." He further highlighted the partnership with Velontra, a company specializing in high-speed air combustion, as a key factor in making hypersonic travel a practical and reliable option.



Hypersonic Flight Testing and the Future

Venus Aerospace is set to conduct its first test flights of the hypersonic jet in 2025. These flights will be a critical step toward commercializing hypersonic travel, with the company aiming to offer services for both commercial passengers and defense applications eventually. The success of these tests could lead to a revolution in how we think about air travel, drastically reducing the time needed to cross vast distances.

The aircraft is designed to take off using conventional jet engines and then switch to its rocket-powered VDR2 engine once it reaches an appropriate altitude. This hybrid system allows for smooth transitions from conventional speeds to hypersonic velocities.



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Industry

While the potential of hypersonic flight is awe-inspiring, it comes with significant challenges. Managing the effects of sonic booms, ensuring passenger safety at such high speeds, and addressing the costs associated with these flights are all hurdles that will need to be overcome before hypersonic travel becomes a standard option. The Concorde, which also pushed the boundaries of airspeed, was eventually retired due to high operating costs and environmental concerns.

However, with the advancements in technology and a renewed focus on sustainability, Venus Aerospace is optimistic about the future of hypersonic jets. “We are excited to partner with Velontra to achieve this revolution in high-speed flight,” Dr. Duggleby said at the Up.Summit, an innovation event where the VDR2 engine was showcased.



The Race to Mach 6

Venus Aerospace is not the only company pursuing the dream of hypersonic flight. Other aerospace giants such as Sierra Space and Hermeus are also racing to develop aircraft capable of reaching Mach 6 speeds. Additionally, China's Space Transportation is working on a "rocket with wings" concept for space tourism and rapid intercity travel.

The competition in hypersonic aviation is heating up, and with multiple players entering the field, the future of high-speed travel is looking more promising than ever. As the technology progresses, passengers may soon find themselves traveling between major cities around the globe in record-breaking time.



The Potential Impact of Hypersonic Jets

The implications of hypersonic flight extend far beyond faster travel times. A hypersonic jet like the Stargazer could transform the global economy by making business trips, international meetings, and even emergency deliveries far more efficient. The ability to cross the Atlantic in an hour could open up new possibilities in commerce, tourism, and even military operations.

Eric Briggs, Velontra's Chief Operating Officer, stated, "We can't wait to dig in, make the first one fly, and ultimately perfect an engine concept that has lived mostly in textbooks but never as a production unit in the air". This sentiment reflects the industry's growing confidence in making hypersonic travel a commercial reality in the coming years.



Conclusion

Venus Aerospace's hypersonic jet represents the next frontier in air travel. With the Stargazer set for test flights in 2025, the possibility of traveling between London and New York in just one hour is inching closer to reality. While there are challenges to overcome, the technological advancements in hypersonic propulsion and high-altitude flight offer a tantalizing glimpse into the future of transportation.

As Venus Aerospace and other companies race to perfect this technology, the world may soon witness a new era of air travel that is faster, more efficient, and more exciting than ever before.



Future Of The F-35 ©Roberto Galan/Getty

Many fighter jets built over the last 70 years have had surprisingly long shelf lives. Some of the Soviet aircraft built in the '50s and '60s are still flown by developing nations in Asia and Africa. That said, American jets are cycled out of inventory much faster than that, especially as the DoD continues to come up with more advanced airframes every decade or so.

An F-35 is built with a planned life expectancy of about 8,000 hours. The expected annual flight time is different for each variant. The F-35A is planned for 250 hours, with 300 hours for the F-35B and 316 hours for the F-35C. That gives an overall range of between 25 and 32 years, although new planes are being built all the time, which can extend the program's lifetime for decades. Regardless of which variant we are talking about, these jets will be around for a long time, and at a cost of [\\$1.7 trillion](#), the DoD had better be getting every last minute out of them.

Eight foreign militaries also fly the F-35, including a mix of NATO members and other U.S. allies, such as Singapore, Israel, and Japan. As the aircraft ages, more countries will want to get their hands on this advanced stealth fighter, and as long as they play by the rules, some of them will receive them. Regardless, it looks like the F-35 will continue to be the world's most advanced stealth fighter for many years to come.

The Lockheed Martin F-35 Lightning II Joint Strike Fighter is the pinnacle of aviation engineering and jet fighter technology. Though it is an extraordinarily expensive aircraft, it comes packed with the most innovative and technically advanced aeronautical systems manufactured to date. Not only is it used by the United States Air Force, Navy, and Marines, but eight other countries keep this advanced aircraft in their inventories for self-defense. The planned procurement for the United States Armed Forces totals 1,762 units for the Air Force, 693 for the Navy and Marines, and hundreds more for overseas buyers, making it the most numerous of any fifth-generation fighter jet in use today.

Previous fighters have been built with specific roles in mind, such as fighter or bomber, and have been made to be used in specific environments, such as an aircraft carrier. This led to the various branches of the military having multiple airframes to maintain along with the continuous supply chain for parts for each model. The F-35 differs by having a single airframe with various alterations to make it suitable for use in a variety of scenarios while utilizing many of the same parts, thus reducing its logistical overhead. However, this means the F-35 Joint Strike Fighter is built into multiple variants, so here is a look at each one and what makes them unique.

Joint Strike Fighter Program Background ©Michael Fitzsimmons/Getty

The story of one of the largest fighter jet programs of the United States Department of Defense (DoD) got its official start in 1996 when the DoD awarded contracts to both Boeing and Lockheed Martin to create a new stealth fighter that could be put into service by the Air Force, Navy, and Marines. While the new aircraft would be built for three service branches, they each had unique requirements, necessitating multiple versions of the aircraft to be built with different specifications.

The end of the Cold War prompted a dramatic shift in military thinking that trickled down from the Pentagon into every area of operation for the military as a whole. Tactics were evolving in this period, and that meant that needs were changing among all branches. Furthermore, budgets were cut in some cases, and funds reallocated in others. This led to a tightening of belts throughout. This is part of the foundation for creating the Joint Strike Fighter Program — to save money. Top brass at the Pentagon wanted a versatile aircraft that would help to reduce costs through economies of scale and the reduction of multiple suppliers.

Both Boeing and Lockheed Martin supplied prototypes in 2001, and Lockheed was awarded the final contract. Being an aviation defense contractor for decades, Lockheed was up to the task, yet problems arose early on and persist until today. Chief among

those problems are cost overruns and delays. Furthermore, many suggest it fails to meet the objectives for which it was built. Regardless, the F-35 eventually entered production and is the most advanced stealth fighter jet on the planet today.

F-35A Description ©Vanderwolf-images/Getty

Meant to replace the fleet of several aging aircraft like the F-16 Fighting Falcon and A-10 Thunderbolt II, the Air Force received the F-35A variant beginning in 2011. These are powered by a single [Pratt and Whitney turbofan](#) engine producing 43,000 pounds of thrust and are built for conventional takeoff and landing (CTOL) as the Air Force primarily operates out of land-based air bases. With less specialized equipment than the other variants, it is the least expensive of the trio.

Designed from the start with a low observable radar cross-section (in other words, stealth), the F-35 combines several elements meant to stay hidden from enemy radar. The fuselage is created such that radar signals will bounce away from the aircraft instead of being redirected back toward the radar signal source. This requires its exterior to be shaped specifically for this purpose and is also coated in an advanced radar-absorbing material. Additionally, all panels and seams must have an absolutely perfect fit because even the smallest panel gap can give away its location.

While it is not perfect, the F-35 assembly in Fort Worth, Texas, provides the best possible aircraft assembly precision in the world. Weapons are also stored in an internal bay for stealth purposes, but the F-35 can still deliver a surprisingly large payload of munitions. While not specifically designed for close-range dogfighting, it is equipped with a 25mm internal cannon should the situation arise.

F-35A Operational Capabilities ©Alex Coppel/Getty

The F-35A used by the Air Force has a wide range of capabilities and can be tailored with various configurations tailored to mission parameters. This will determine what armament will be installed into its two internal weapons bays and whether anything will be affixed to its six external hardpoints that are used when stealth flying is not necessary. Otherwise, all munitions are stored in the weapons bays, which keep them concealed from radar tracking.

As a multirole fighter, this fighter can do more than shoot missiles and bullets at the enemy. It is fitted with an extraordinarily complex and advanced communications suite, which includes an array of sensors that gather multiple data points, heightening

situational awareness and sharing it with others involved in a particular mission. Furthermore, an individual F-35A can serve as a communications hub, relaying information to and from other pilots in a squadron, as well as another communications aircraft, such as an AWACS plane, in the area and a Navy command vessel sitting miles offshore. It is a fighter jet that doubles as a complete electronic warfare command station in the sky.

Although the United States Military has had a presence in the Middle East for decades, F-35 fighters were only recently deployed to the area beginning in 2019. These arrived in the area from Hill Air Force Base in Utah. The range of an F-35A is more than 1,350 miles using internal fuel tanks, but the Air Force operates a fleet of tanker aircraft, effectively giving their F-35As unlimited range with aerial refueling and the ability to deploy from Utah directly to the United Arab Emirates.



F-35B Description©Handout/Getty

With a directive as an expeditionary force, the [United States Marine Corps](#) is tasked with establishing a foothold in the littoral zone where a mission will occur. This is why their variant of the F-35 is so unique.

Whereas the F-35A, operated by the Air Force, is a traditional fighter for missions originating at air bases with runways, the F-35B is meant for operating at sea. It has an

additional fan at the rear of the cockpit that provides additional thrust directly downward, giving this aircraft short takeoff and vertical landing (STOVL) capability. This is done by a combination of shaft-driven thrust fans, the Rolls-Royce LiftSystem, installed just behind the cockpit and the rear thrust nozzle.

This splits the power between the main engine, providing thrust through its nozzle, and the shaft, driving a pair of counter-rotating fans blowing around 20,000 pounds of unheated air down through a vane box that directs the airflow. The rear thrust nozzle is fitted with a three-bearing swivel nozzle (3BSN). This can rotate the nozzle 90 degrees such that its thrust is also directed straight down. To keep low radar observability intact, the downward thrust fans are fully enclosed in a compartment within the airframe.

Marines have operated STOVL aircraft for years. Perhaps the best-known model is the Harrier Jump Jet. By creating a new fighter that can be equipped with this system, the Marines get access to a cutting-edge stealth jet with STOVL capability without having to maintain another individual piece of equipment with its own separate supply line.



F-35B Capabilities ©U.S. Navy/Getty

The Marine Corps is an expeditionary force tasked with securing beachheads and establishing its presence on the shores and openings into other waterways. They have an extremely important mandate when moving into hostile territory, making quick

maneuvers with little infrastructure or support available. This can also include some degree of island hopping, depending on where an objective is to be met. The F-35B is uniquely qualified to help them obtain their objectives in these situations. Without the luxury of well-maintained airstrips, operating with little to no runways is crucial.

The F-35B can take off with almost no runway and hover in place for short periods. This also gives it the ability to land vertically. While some units operate alongside the Navy and use its carriers to execute missions, the Corps also maintains a fleet of its own ships. The newest America-class assault ships have been built with a focus on aviation, providing facilities for operating the F-35B.

Built with a flight deck much shorter and smaller than an aircraft carrier, the Marines can run sorties with their F-35B aircraft while maintaining much of the same capabilities that other branches realize with their aircraft. The tradeoff for having STOVL is less payload capacity and shorter range. However, when each service branch works together to exploit the strengths of all three variants, the results will be overwhelming.





F-35C Description©Rancho_runner/Getty

The United States Navy has a long and proud history of serving its country in times of war and peace, defending its shores, and mitigating threats in faraway oceans. It has also maintained its fleet of fighter aircraft, more often than not using its own models built with specific naval requirements in the design. As a result, the Navy has trained some of the best pilots in the world who support our ground-based forces with overwhelming air power against adversaries and is equipped with some of the best fighter jets ever created.

The Navy received the F-35C variant, optimized for use on aircraft carriers. Most of its specifications are in line with the Air Force version, but a few key differences separate it. The most prominent difference is in the wings. For carrier duty, the airframe uses folding wingtips that allow for more compact storage. It is also optimized for carrier duty by having stronger landing gear and a strengthened airframe meant to absorb the immense energy from tailhook carrier landings and catapult-assisted takeoffs.

The wings, which are nine feet wider than the others, and the tail section have larger control surfaces that assist in low-speed approaches while offering a greater load capacity and increased range. Despite having these many alterations, few tradeoffs are made to operational effectiveness, meaning the F-35C is ready for nearly any mission as the other variants in service.



F-35C Capabilities

©Wpa Pool/Getty

The Navy variant of the F-35C possesses the same communications suite as the others, which is crucial in coordinating with the ships in a [carrier strike group](#), which can be made up of the aircraft carrier accompanied by guided-missile cruisers, destroyers, frigates, submarines, and a supply ship. This includes the relaying of intelligence gathered from its advanced sensors to commanders in real-time, giving them the ability to make informed decisions and give orders based on up-to-date tactical information. Communication between all the commanders and a squadron of aircraft is crucial to executing missions and keeping personnel safe.

The inclusion of the F-35C on the flight deck represents the introduction of stealth fighters for the first time into navy deployments. This gives Naval squadrons superior survivability with the ability to strike inland undetected and return rapidly back to the safety of the strike group. Previous pilots have had to rely on their cunning to pull off the same missions.

While the F-35C has been around for several years, its first deployment with a carrier strike group occurred only in 2021. The first time at sea was with the USS Carl Vinson for a routine deployment in which they performed several naval exercises on the open ocean. Thus, no data yet exists on how the jet performs in a real combat situation.

F-35 vs. J-35A: Breaking down the features and specs of top fifth-generation jets

In November 2024, the Zhuhai Airshow unveiled a lineup of advanced military technology, prominently featuring the J-35A—a new fifth-generation stealth fighter from China’s Shenyang Aircraft Corporation. This event showcased a range of aircraft, drones, and munitions. It highlighted the significant advancements of the People’s Liberation Army (PLA) and PLA Air Force (PLAAF) in modern air combat capabilities.

Amidst various hardware, the J-35A stood out, drawing immediate comparisons to the American Lockheed Martin F-35 Lightning II, one of the most advanced and widely adopted fighters globally. Both aircraft represent the pinnacle of stealth technology and are designed to meet the rigorous demands of contemporary warfare. However, despite their apparent similarities in design and purpose, the J-35A and F-35 embody distinct strategic priorities and technological paths shaped by the unique defense needs of China and the United States.



A side-by-side comparison of the American F-35 (Left) and the Chinese J-35A (Right) – Sources: 1 , 2

This article compares these fighters against each other, exploring their design, performance, and role within their respective military frameworks. By comparing these advanced jets, we aim to understand their technological capabilities and the broader implications of their development in the context of global military dynamics and cybersecurity concerns.

Background and strategic positioning of the J-35A stealth fighter

The J-35A, originating from the Shenyang Aircraft Corporation's FC-31 technology demonstrator, represents a significant evolution in [Chinese military aviation technology](#). Initially conceptualized as a potential export without direct PLA support, the FC-31 underwent substantial modifications to meet the stringent requirements of modern air combat, showcasing its capabilities through various prototypes first flown in 2012 and 2016.

By the mid-to-late 2010s, the design caught the PLA Navy's (PLAN) attention, which led to its development into a carrier-borne fifth-generation fighter, tentatively named the [J-35](#). The first prototype, flown in October 2021, featured notable enhancements such as an enlarged folding wing, reinforced landing gear, and a catapult launch bar. These modifications, along with an enhanced dorsal fuselage hump and sophisticated sensor array, indicated a mature design aimed at carrier operations.

In the past, the PLA Air Force (PLAAF) showed interest in adapting this advanced platform for land-based operations. By 2023, emerging prototypes with adaptations such as a reduced wingspan pointed to specific modifications tailored to the PLAAF's operational needs. This version was officially designated as the J-35A during the Zhuhai Airshow 2024, coinciding with the PLAAF's 75th anniversary.

The J-35A and its variants often draw comparisons to the United States' F-35, reflecting shared design features typical of medium-sized, fifth-generation fighters, such as dual-side air intakes and similar wing and tail configurations.

While these similarities have sparked discussions about potential espionage and technology transfer—particularly in the context of alleged Chinese cyber operations targeting F-35 data—the convergence seen in other contemporary fighters like the KF-21 and AMCA suggests that these design traits may be driven more by a pursuit of optimal aerodynamic and operational solutions than by direct copying.

The J-35A is strategically positioned within the PLAAF as a versatile, medium-weight complement to the heavier J-20, expanding [China's fleet of fifth-generation fighters](#). This development strategy aligns with the varied operational requirements of the Chinese military, from achieving air superiority to conducting precise strike missions. The F-35, in its role, continues to be a central asset for the U.S. and its allies, providing a critical blend of stealth, advanced sensor integration, and multi-role capabilities.

Furthermore, China's military advancements include the operation of another stealth fighter, the J-20 air superiority aircraft, and the ongoing development of the H-20 flying wing stealth bomber, as reported in a [2023 Pentagon document](#) on China's military forces.

Design comparison of J-35A and F-35 fighter jets

Stealth and airframe design

Both the J-35A and the F-35 are engineered with an emphasis on low-observable, stealth technology, which is evident in their sleek and smooth airframes. These designs are crucial for minimizing radar cross-section (RCS) and enhancing operational efficacy by staying undetected during missions. The aircraft feature streamlined surfaces and curvature that disrupt radar wave detection, a fundamental aspect for stealth operations.

Vertical stabilizers and canards

The J-35A and F-35 incorporate similar aerodynamic components like canards and vertical stabilizers arranged in a distinctive V-like structure. This setup not only aids in maintaining a stealth profile but also plays a critical role in reducing turbulence, further decreasing radar visibility. However, subtle differences in their designs underscore divergent engineering approaches. The J-35A's stabilizers are slightly wider and set at a different angle, potentially offering better aerodynamic

performance tailored to the specific operational requirements of the Chinese military. This could influence the aircraft's agility and its RCS.

Conversely, the F-35 features more sharply angled stabilizers optimized for an enhanced stealth profile. This design choice reflects a deliberate focus on radar evasion, integral to the [F-35's role in U.S.](#) and allied operations, ensuring superior performance even in challenging conditions.

Cockpit ergonomics and visibility

The cockpit design of both aircraft fuses functionality and advanced technology, designed to meet the rigors of modern air combat. Each cockpit has a rounded glass canopy, optimizing pilot visibility and situational awareness—crucial during high-speed, high-stress combat scenarios.

The J-35A's cockpit is narrower with a simpler design and less curvature in the canopy glass, suggesting a focus on practicality and cost-efficiency. However, this design could slightly elevate the RCS, albeit still adhering to stealth norms. In contrast, the F-35's cockpit is more expansive, featuring a sophisticated, rounded canopy with extensive glass coverage. Specialized coatings on the F-35's canopy enhance its stealth capabilities, significantly reducing its radar signature while prioritizing pilot comfort and visibility.

Engine design and stealth optimization

The rear sections of the J-35A and F-35 showcase significant differences in design philosophy, particularly around the engine housings. The J-35A opts for a more enclosed engine design with fewer visible edges and a smoother outline around the exhaust, aimed at minimizing radar reflections—a crucial element in stealth technology. This design is likely optimized to meet the J-35A's unique performance specifications, possibly prioritizing operational flexibility in varied combat scenarios.

In contrast, the F-35's exhaust system is more intricate, with defined features that reflect advanced American engineering practices aimed at maximizing stealth. The pronounced design and use of cutting-edge materials in the F-35's exhaust system illustrate a comprehensive approach to reducing its radar footprint, aligning with the aircraft's strategic role in achieving air superiority.

Wing design and aerodynamic efficiency

The wing designs of the J-35A and F-35 further reflect their distinct tactical priorities. The J-35A features slightly more angular wings, designed to enhance maneuverability—a critical factor in dogfights and rapid tactical shifts. This design choice supports the J-35A's presumed role in regional dominance and quick-response scenarios.

The F-35, however, sports smoother, more contoured wings that align with its overarching stealth strategy. These wings are engineered to minimize radar reflections and maintain stability at high speeds, supporting the F-35's role in deep-strike missions and sustained air operations over hostile territory.

Air intakes and landing gear

The design variations extend to both aircraft's air intakes and landing gear. The J-35A's air intakes are wider and more angular, possibly increasing engine airflow and improving performance but at a potential cost to its stealth profile. Meanwhile, the F-35's air intakes are designed with stealth as a paramount consideration, featuring a rounded, smooth structure that enhances airflow while minimizing radar detection.

The J-35A's landing gear is simpler and more robust, likely designed to endure diverse and potentially rugged operational environments. On the other hand, the F-35's landing gear is more complex, incorporating features that reduce radar cross-section and enhance the overall stealth profile, which is critical for operations in highly contested areas.

Performance and role of the J-35A and F-35 stealth fighters

Speed, range, and endurance

The J-35A achieves a maximum speed of Mach 2.0, surpassing the F-35's top speed of Mach 1.6. This superior speed equips the J-35A with an advantage in fast-paced combat scenarios, particularly in intercepting high-speed targets, which is crucial for air superiority roles. The design supports quick maneuvers and rapid response, aligning with its intended use within the People's Liberation Army Air Force (PLAAF).

Conversely, the F-35 excels in range and versatility, featuring a longer operational range of approximately 2,220 kilometers compared to the J-35A's 1,200 kilometers. This extended range makes the F-35 more suitable for long-range missions and deep-strike capabilities. It reflects its role in projecting power over vast distances and supporting varied mission profiles, from ground attack to reconnaissance.

Originally thought to employ Russian RD-33 engines, the J-35A is likely to transition to using more advanced Chinese-developed [WS-13E or WS-21 engines](#). Future models are expected to incorporate the WS-19 engines, enhancing their thrust and performance capabilities.

Both aircraft can refuel in-flight, significantly extending their operational reach and endurance. This allows for prolonged deployment in contested areas without ground support.

Advanced avionics and weaponry

The J-35A incorporates a suite of advanced Chinese-made avionics, including AESA radar, infrared search and track systems, and comprehensive electronic warfare capabilities. These systems enhance the aircraft's awareness of its

surroundings, which is crucial for engaging multiple threats simultaneously and adapting to dynamic combat environments.

The F-35 has the AN/APG-81 AESA radar, AN/AAQ-37 Distributed Aperture System, and AN/ASQ-239 electronic warfare suite, offering unmatched sensor fusion and situational awareness. This integration allows the F-35 to detect, track, and engage targets at considerable distances, even in highly contested environments.

Both the J-35A and F-35 maintain their stealth profiles by carrying weapons internally. The J-35A can carry up to 7,000 kilograms of payload, while the F-35 has a slightly higher capacity of 8,160 kilograms. This internal carriage design is critical for maintaining a low radar cross-section during missions.

The J-35A emphasizes speed and agility for regional operations, while the F-35 focuses on versatility, range, and global interoperability. These aircraft demonstrate the [advanced state of modern air combat](#) technologies and illustrate the critical role of securing intellectual property in maintaining national defense advantages.

Cyber espionage and the theft of F-35 design data

Frank Kendall, the Defense Acquisitions Chief in 2013, highlighted the [compromise of unclassified F-35 data](#) despite the classified information remaining secure. This breach reportedly allowed competing powers, particularly highlighted in Pentagon reports linking the Chinese government and military, to advance their military technology programs.

In 2014, a Los Angeles grand jury indicted Chinese national Su Bin for assisting PLA hackers in stealing over 630,000 files related to the F-35 and other critical U.S. aircraft from 2008 to 2014. Bin's role involved facilitating the translation and targeting of sensitive defense technology, underscoring the depth of espionage activities to undermine U.S. technological supremacy.

First Clear Image of a Chinese J-20 Stealth Fighter Launching a PL-10 Air-to-Air Missile Emerges



A J-20 flying overhead during the 2018 iteration of the Zhuhai Air Show, displaying its internal weapons bays with a full load. (Image credit: Telegram/Sina Weibo)

The side internal weapons bays are designed to house the PL-10 short-range air-to-air missile. Additionally, the J-20's bay mechanics and internal design showcase

a fascinating integration of engineering precision and tactical air combat functionality, highlighting how these aspects influence and complement each other.

The first clear [image](#) of a PLA Air Force J-20 stealth fighter firing a PL-10 short-range AAM (Air-to-Air Missile) has emerged. The missile is seen leaving the [right-side internal weapons](#) bay of the aircraft in the image, that bears the logo of the PLA Air Force and appears to have been first posted on the PLAAF's official Weibo account.

This follows a very short one-second clip that surfaced online in [Nov. 2023](#), that showed a missile leaving the same side of the jet in a similar fashion, and also bore the logo of the Chinese military's publicity wing and the "new" image may well be just a screenshot from the previous clip.

While it is highly unlikely that the J-20 will not have undertaken live weapons firing prior to this, and that this being only one of the rare moments it has been captured on camera, it is interesting to see the secretive jet in action.

As such, it is near impossible to know the specific tactical situation in which the PL-10 was fired, or if there was a pilotless target drone involved. Its American counterparts, the F-35 and the F-22 meanwhile have frequently been clicked and recorded in weapons firings, mostly by its own media-friendly military.

Image and identity of the missile

The latest image was shared by leading Chinese military aviation researcher [Andreas Rupprecht](#). While the missile is easily identifiable in the current image, the clip from Nov. 2023 is grainy. Yet it can be confirmed to be the missile for the simple reason that the side internal weapons bays are meant to house the short and medium-range AAMs like the PL-10. Moreover, both the

video and image clearly shows the trajectory of the smoke streak tracing itself to the side bay, implying the missile has to be the PL-10. It cannot be the PL-15 since it would be too large to fit inside the side weapons bay. The PL-15 BVR (Beyond Visual Range) AAM – whose rumored 300 km range is said to have spurred the development of the [AIM-250 JATM](#) (Joint Advanced Tactical Missile) – is first dropped from the underbelly concealed weapons bays, following which the motor ignites. That section carries four PL-15s, two in each of the compartments, exactly under the engine nacelles. The PL-10 meanwhile is launched off the rails.

Whether the latest image is a clearer captured still of the Nov. 2023 video only being released now, or a different picture altogether from a separate exercise, is not clear. And the Chinese military almost never delves into weapons specifications in their publicity material, except for pictures and videos. In both situations, the J-20 appears to be flying in level flight.

J-20 design and dogfighting

It is also warranted to look at the interesting mechanics of the J-20's internal bay functions and designs, and how both the engineering and air combat tactics feed into each other. One has to go back to the 2018 Zhuhai Air Show when the J-20 first opened up its underbelly and side weapons bays while flying overhead, displaying its full payload. The ventral stores showed the PL-15s. But it was the arrangement of the side bays that showed some fascinating techno-tactical thinking.

The bay showed a mechanism where rounded semi-circular launcher rails rolled out carrying a missile, but the bay door remained closed. The F-22's and the F-35's side weapons hold outside the engine intakes meanwhile has the launcher rail in a retracted position. It is pushed out in an extending-out motion, and comes to a stop almost in a diagonal position. The F-35 meanwhile has the launching rails both on the inside of the weapons bay and on the inside of the opening bay doors. On a different note, the J-20's weapons bay also looks less engineered and less cluttered than the F-35 and the F-22.

The launcher-carriage-bay door arrangement on the J-20 translates into a mechanism where the door opens and the launcher rolls out with the missile, with the door immediately closing again. In a dogfight, where stealth is not a priority, the pilot can keep the missile ready with a launcher extended before releasing the possibly high off-boresight LOAL (Lock-On After-Launch) PL-10. There are differing claims on the PL-10's guidance. A November 2020 [report](#) by the CASI (China Aerospace Studies Institute) says it has an IR (Infra-Red) seeker that can be slaved to an helmet-mounted cueing system.

If stealth is a concern where the pilot expects to be targeted by BVR missiles while being in a dogfight, he can quickly open the bay doors and release the missiles. This is because opening and keeping the bay doors open provides an added reflective surface – although it would be questionable to how much the few seconds of radar visibility might make a difference.

J-20s with the homegrown supercruise capable [WS-15 engine](#), with thrust-vectoring nozzles might achieve the sharp performance required for the tight, high-G maneuvers. This is because earlier footage of its flights had shown plain flypasts. This had led to a conclusion that the jet, although influenced by the F-35, was meant more as an airborne sniper. Using stealth and jamming, it would slip through enemy fighter screens and take out vulnerable support aircraft like refueling tankers and AWACS.

Only time will tell how the jet will be employed and perform.

Significance

Moreover, it also comes close on the heels of the twin-seat version of the J-20, the J-20S, being officially unveiled at the recently concluded Zhuhai Air Show. That variant had been [spotted in a factory yellow paint scheme](#) in August 2022, and some assessments believe it to be more suited for controlling wingmen and collaborative drones/UCAVs. The rear-seated pilot WSO (Weapons Systems Operator) would undertake that responsibility, along with the more advanced EW (Electronic Warfare) functions.

[Screen grabs](#) from a digital representation on CCTV (China Central Television) that showed a J-20 flying with three wingmen UCAVs that were identified as GJ-11s, suggest a slightly longer cockpit, suggesting a twin-seat variant.

This makes the J-20 the first fifth-generation, dual-seat stealth fighter. It is also possible that the J-20S variant, by the time it reaches serial production, would be flying with China's indigenously developed WS-15s. But these are expectant developments with Chinese military aviation, given how it has purposely built its aircraft and aircraft factories to not repeat some mistakes of America's defense industry.

Neither of the U.S. fighters are being produced at the scale the J-20 is being churned out.

Manned-unmanned team: USAF's high-tech flight test pairs XQ-58A Valkyrie with F-35s



Manned-unmanned team: USAF's high-tech flight test pairs XQ-58A Valkyrie with F-35s

In a groundbreaking demonstration, the US Air Force has successfully conducted tests with its experimental unmanned aircraft, the XQ-58A Valkyrie, in conjunction with F-35 fighter jets.

This historic flight, which featured two F-35As working alongside the Valkyrie, marks a significant advancement in the military's vision of manned-unmanned teaming.

Lockheed Martin, the developer behind the F-35 program, praised the collaboration, emphasizing that integrating the F-35A with the autonomous Valkyrie enhances their combat capabilities.

"This pairing creates a team that is smarter and faster," the company noted, showcasing a pivotal evolution in aerial warfare.

High-tech flight test

The combination of the F-35A Lightning II and the Kratos XQ-58A Valkyrie represents a significant shift in the US Air Force's combat strategy, moving towards a more distributed and networked approach.

The F-35A, renowned for its short takeoff and vertical landing (STOVL) capabilities, is a key asset in the Air Force's expeditionary operations.

It delivers unparalleled situational awareness and advanced strike potential.

Integrating the Valkyrie as a loyal wingman expands the F-35A's operational potential, functioning as a force multiplier.

The Valkyrie is designed to undertake high-risk missions such as electronic warfare and surveillance, which traditionally threaten pilot safety.

This semi-autonomous aircraft can be operated autonomously or controlled directly by an F-35A pilot, enhancing mission flexibility and operational range.

This innovative partnership is exceptionally relevant for the Air Force's distributed operations strategy, particularly in contested environments where smaller, mobile units need reliable air support.

The Valkyrie's low cost enhances the Air Force's ability to execute more daring missions without endangering human pilots, allowing for an increased willingness to take operational risks.

One of the most significant advantages of this teaming is improved survivability and lethality in combat scenarios.

The F-35A, equipped with cutting-edge sensors and [stealth](#) technology, can function as a command center, effectively designating targets and orchestrating attacks involving multiple Valkyries. This strategy reduces detection risks while overwhelming enemy defenses through sheer numbers and diverse attack vectors.

F-35 and XQ-58A

Moreover, by delegating certain tasks to the Valkyrie, F-35A pilots can concentrate on strategic decision-making, thereby optimizing mission effectiveness and execution.

In a related development, the US Marine Corps has also tested the capabilities of the XQ-58A alongside F-35s.

During these tests, the Valkyrie operated as a forward-deployed sensing unit, providing vital threat-targeting data to the Marine's fifth-generation aircraft.

This integration facilitated the rapid closure of advanced kill chains, demonstrating the Valkyrie's operational value.

Utilizing a common tactical data link, the Valkyrie enhanced situational awareness by sharing critical information with ground and airborne assets within the joint network.

Col. Derek Brannon, Branch Head for the Cunningham Group at the Deputy Commandant for Aviation, stated, "This test marked another milestone for the

Marine Corps' unmanned tactical aircraft program. The success of the flight during Emerald Flag further advanced the manned-unmanned teaming concept for the entire Joint Force."

As the military continues to explore the approach between manned and unmanned systems, the successful integration of the [XQ-58A](#) Valkyrie with the F-35A highlights a transformative approach to modern warfare.

With enhanced capabilities, these next-generation aircraft are poised to redefine tactical operations and ensure the US military maintains its strategic edge in future years.

Game-Changing Aircraft That Shaped Aviation History

P-51 Mustang

The P-51 Mustang was a long-range fighter that played a critical role in WWII. With its powerful Merlin engine and excellent range, it provided an effective escort to Allied bombers over Europe, significantly reducing losses and contributing to the success of air campaigns.

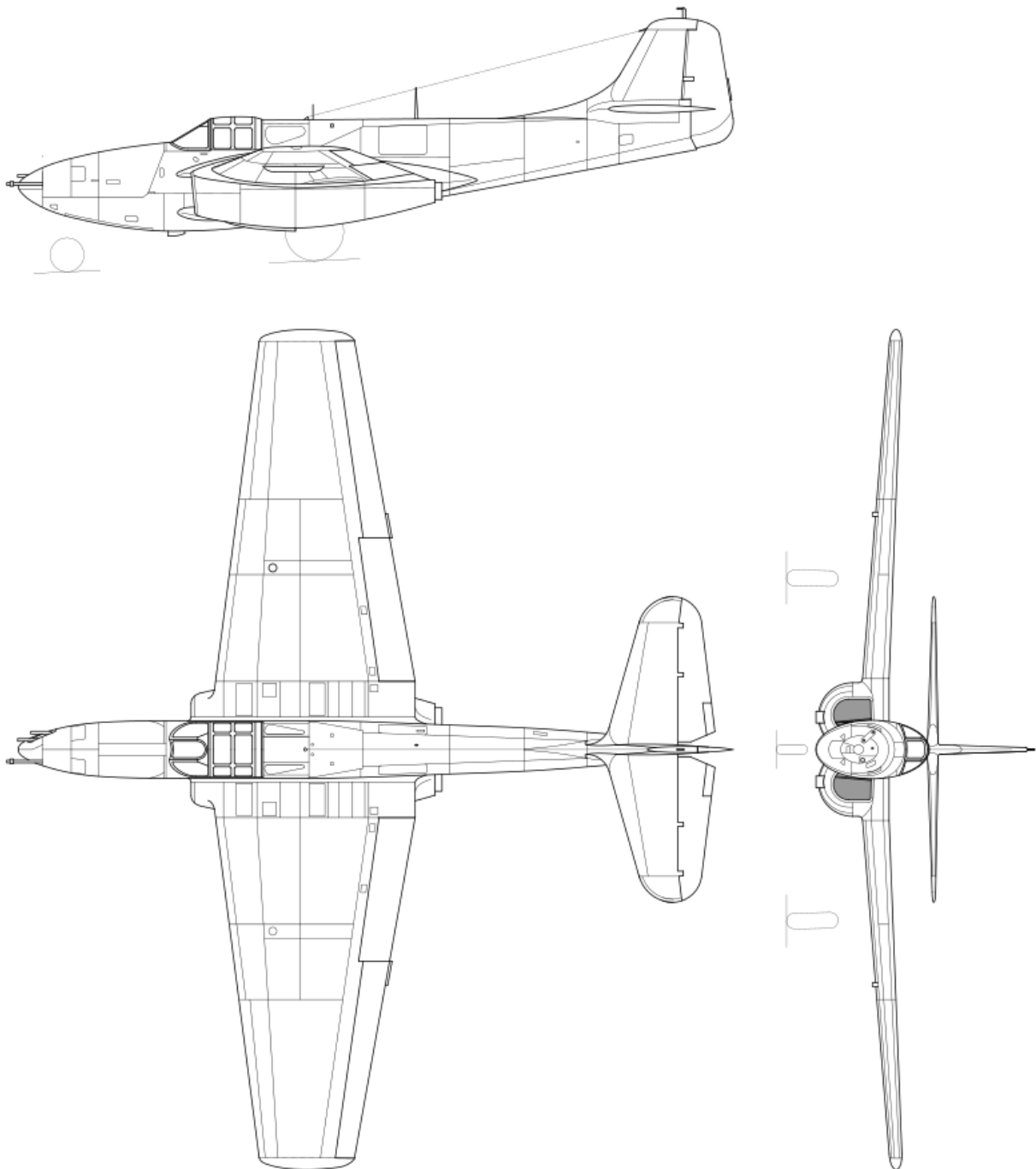


Supermarine Spitfire

The Supermarine Spitfire was a key aircraft in the Battle of Britain during WWII, known for its speed, agility, and elliptical wing design. It played a crucial role in defending the UK against German air attacks and became a symbol of Allied resistance.



BELL P-59 AMERICAS FIRST JET FIGHTER AIRCRAFT



Bell P-59 Airacomet

"P-59" redirects here. For other uses, see [P-59 \(disambiguation\)](#).

"XP-59" redirects here. For the unrelated Bell XP-59 fighter, see [Bell XP-52](#).

P-59 Airacomet



Bell P-59B Airacomet at the [National Museum of the United States Air Force](#), [Dayton, Ohio](#)

General information

Type	Fighter/Jet Trainer
National origin	United States
<u>Manufacturer</u>	Bell Aircraft
Designer	Robert A. Wolf and Herbert L. Bower
Primary users	United States Army Air Forces • United States Navy • Royal Air Force
Number built	66

History

First flight	1 October 1942
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The **Bell P-59 Airacomet** is a single-seat, twin [jet](#)-engine [fighter aircraft](#) that was designed and built by [Bell Aircraft](#) during [World War II](#). It was the first jet produced in the United States. As the British were further along in jet engine development, they donated

an engine for the United States to copy in 1941 that became the basis for the [General Electric J31](#) jet engine used by the P-59 a year later. Because the plane was underpowered, the [United States Army Air Forces](#) (USAAF) was not impressed by its performance and canceled half of the original order for 100 fighters, using the completed aircraft as trainers. The USAAF would instead go on to select the [Lockheed P-80 Shooting Star](#) as its first operational jet fighter. Although no P-59s entered combat, the aircraft paved the way for later generations of U.S. turbojet-powered aircraft.

Design and development

[\[edit\]](#)



The [Power Jets W.1](#) engine that was later to be produced by GE as the [General Electric J31](#)

Major General [Henry H. "Hap" Arnold](#) became aware of the UK's jet program when he attended a [taxiing](#) demonstration of the [Gloster E.28/39](#) in April 1941. The subject had been mentioned, but not in-depth, as part of the [Tizard Mission](#) the previous year. He requested and was given, the plans for the aircraft's powerplant, the [Power Jets W.1](#), which he took back to the U.S. He also arranged for an example of the engine, the Whittle W.1X turbojet, to be flown to the U.S. on 1 October in a [Consolidated B-24 Liberator](#),^[1] along with drawings for the more powerful [W.2B/23](#) engine and a small team of [Power Jets](#) engineers. On 4 September, he offered the U.S. company [General Electric](#) a contract to produce an American version of the engine, which subsequently became the [General Electric I-A](#). On the following day, he approached [Lawrence Dale Bell](#), head of Bell Aircraft Corporation, to build a fighter to utilize it. Bell agreed and set to work on producing three prototypes. As a [disinformation](#) tactic, the USAAF gave the project the designation P-59A, to suggest it was a development of the unrelated [Bell XP-59](#) fighter project which had been canceled. The design was finalized on 9 January 1942, and construction began. In March, long before the [prototypes](#) were completed, an order for 13 YP-59A pre-production aircraft was added to the contract.^[2]



Details of fuselage and undercarriage of a P-59B, showing the nose armament

The P-59A had an oval cross-section, all-metal [stressed skin](#) semi-[monocoque](#) fuselage that housed a single pressurized [cockpit](#). The mid-mounted, straight wing had two [spars](#) plus a false spar in the inner panel. The electrically powered [tricycle landing gear](#) was attached to the center spar. The pair of [General Electric J31](#) turbojets were positioned under the [wing roots](#) in streamlined [nacelles](#). The armament was located in the nose of the aircraft; two of the three XP-59As and most of the YP-59As had a pair of 37-millimeter (1.5 in) [M10 autocannon](#). Later aircraft, including the production models, had one M10 autocannon and three 0.5-inch (12.7 mm) [AN/M2 Browning heavy machine guns](#). The aircraft carried a total of 290 US gallons (1,100 L; 240 imp gal) of fuel in four [self-sealing tanks](#) in the inner wing panels. Both production models could carry 1,590-US-gallon (6,000 L; 1,320 imp gal) [drop tanks](#) under the wings. In addition, the P-59B was provided with a 66-US-gallon (250 L; 55 imp gal) fuel tank in each outer wing panel.^{[3][4]}

The crated prototype had been built on the second floor of a disused [Pierce-Arrow](#) factory, but its components were too big to fit through any [elevator](#) and required a hole to be broken in the brick outer wall to remove the first XP-59A. It was shipped to Muroc Army Air Field (today, [Edwards Air Force Base](#)) in California on 12 September 1942 by train for [flight testing](#). The aircraft first became airborne during high-speed [taxiing](#) tests on 1 October with Bell test pilot [Robert Stanley](#) at the controls, although the first official flight was made by [Colonel Laurence Craigie](#) the next day. While being handled on the ground, the aircraft was fitted with a dummy [propeller](#) to disguise its true nature. When heavy rains flooded [Rogers Dry Lake](#) at Muroc in March 1943, the second prototype was towed 35 mi (56 km) to [Hawes Field](#), an auxiliary airfield of Victorville Army Airfield, later [George Air Force Base](#), over a public road. After one flight on 11 March, security concerns caused the jet to be transferred to nearby [Harper Lake](#) where it remained until 7 April.^{[5][6]}

Five of the Airacomets, a pair of XP-59As, two YP-59As, and a P-59B had open-air flight observer cockpits (similar to those of [biplanes](#)) fitted in the nose with a

small [windscreen](#), replacing the armament bay. The XP-59As were used for flight demonstrations and testing, but one of the latter pair was used as a "[mother ship](#)" for the other modified YP-59A during [remote control](#) trials in late 1944 and early 1945. After the [drone](#) crashed during take-off on 23 March, a P-59B was modified to serve as its replacement.^{[7][8]} During diving trials in 1944, one YP-59A was forced to make a [belly landing](#) and another crashed when its entire [empennage](#) broke away.^[9]

Over the following months, tests on the prototypes and pre-production P-59s revealed a multitude of problems including poor engine response and reliability (common shortcomings of all early turbojets), poor [lateral](#) and [directional stability](#) at speeds over 290 mph (470 km/h), so that it tended to "snake" and was a poor gunnery platform. The performance was greatly hampered by the insufficient thrust from its engines that was far below expectations. The Army Air Force conducted combat trials against propeller-driven [Lockheed P-38J Lightning](#) and [Republic P-47D Thunderbolt](#) fighters in February 1944 and found that the older aircraft outperformed the jet. It, therefore, decided that the P-59 was best suited as a training aircraft to familiarize pilots with jet-engine aircraft.^{[10][11]}

Even as deliveries of the YP-59As began in July 1943, the USAAF had placed a preliminary order for 100 production machines as the P-59A Airacomet, the name having been chosen by Bell employees. This was confirmed on 11 March 1944 but was later cut to 50 aircraft on 10 October after the procurement bureaucracy had digested the earlier evaluation.^{[12][13]}

Operational service

[\[edit\]](#)



The first production P-59A with a [Bell P-63 Kingcobra](#) behind

The 13 service test YP-59As had a more powerful engine than their predecessor, the [General Electric J31](#), but the performance improvement was negligible, with top speed increased by only 5 mph and a reduction in the time they could be used before an overhaul was needed. One of these aircraft, the third YP-59A ([S/n](#): 42-108773) was supplied to the [Royal Air Force](#) (receiving [British serial](#) RJ362/G), in exchange for the first production [Gloster Meteor I](#), EE210/G.^[14] British pilots found that the aircraft compared very unfavorably with the jets that they were already flying. Two YP-59A Airacomet (42-108778 and 42-100779) were also delivered to the U.S. Navy where they were evaluated as the "YF2L-1" but were quickly found completely unsuitable for [carrier operations](#). Three P-59Bs were transferred to the Navy in 1945–1946, although they kept their designations. The Navy used all five of its jets as trainers and for flight testing.^[15]

Faced with their own ongoing difficulties, Bell eventually completed 50 production Airacomets, 20 P-59As and 30 P-59Bs; deliveries of P-59As took place in the fall of 1944.^[16] The P-59Bs were assigned to the [412th Fighter Group](#) to familiarize AAF pilots with the handling and performance characteristics of jet aircraft.^[17] While the P-59 was not a great success, the type did give the USAAF and the USN experience with the operation of jet aircraft, in preparation for the more advanced types that would shortly become available.^[12]

Variants

[\[edit\]](#)



XP-59A with the short-lived red-outlined national markings (June 1943 to September 1943)

XP-59

Unrelated piston engine-powered pusher-propeller design developed from the [Bell XP-52](#). Not built.^[18]

XP-59A

Prototype of the new jet engine-powered aircraft, three built, serial numbers 42-108784/108786.^[19]

YP-59A

Series of test aircraft, 13 built, serial numbers 42-108771/108783.^[20]

YF2L-1

Two YP-59A (42-108778/108779) delivered to the US Navy for carrier evaluation as Bu63960/63961.^[21]

P-59A

First production version, 20 built, serial numbers 44-22609/22628. Redesignated ZF-59A in June 1948.^[22]

XP-59B

Study for a single-engined P-59A.^[23]

P-59B

Improved P-59A. 80 aircraft ordered but only 30 built, serial numbers 44-22629/22658, further 50 (44-22659/22708) canceled. Redesignated ZF-59B in June 1948.^[24]

Operators

[\[edit\]](#)

-  [United Kingdom](#)
 - [Royal Air Force](#) received one aircraft, becoming *RJ362/G*, in exchange for a [Gloster Meteor I](#) *EE210/G*.^[25]
-  [United States](#)

- [United States Army Air Forces](#)^[26]
 - [412th Fighter Group](#)
 - [29th Fighter Squadron](#)
 - [31st Fighter Squadron](#)
 - [445th Fighter Squadron](#)
- [United States Navy](#)

Surviving aircraft

[\[edit\]](#)



A Bell P-59A Airacomet at the March Field Air Museum in 2013

Six P-59s are known to survive today.

On display:

P-59A

- 44-22614 – [March Field Air Museum](#), [March Air Reserve Base](#) (former [March AFB](#)) in [Riverside, California](#).^[27]

P-59B

- 44-22633 – [Edwards AFB](#).^[28]
- 44-22656 – [Pioneer Village \(Nebraska\)](#) in [Minden, Nebraska](#).^[29]
- 44-22650 – [National Museum of the United States Air Force](#) at [Wright-Patterson Air Force Base](#) near [Dayton, Ohio](#).^[30]

In storage:

XP-59A

- 42-108784 – [National Air and Space Museum](#)^[31]

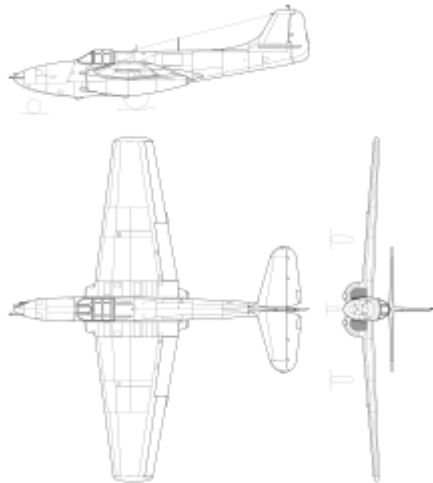
Under restoration:

YP-59A

- 42-108777 – As of 2020, being restored to flying condition by the [Planes of Fame Museum](#) in [Chino, California](#).^[32]

Specifications (P-59B)

[\[edit\]](#)



3-view drawing of the P-59

Data from *The American Fighter*^[33] ^[34]

General characteristics

- **Crew:** 1
- **Length:** 38 ft 10 in (11.84 m)
- **Wingspan:** 45 ft 6 in (13.87 m)
- **Height:** 12 ft 4 in (3.76 m)
- **Wing area:** 386 sq ft (35.9 m²)
- **Airfoil:** root: [NACA 66-014](#); tip: [NACA 66-212](#)^[35]
- **Empty weight:** 8,165 lb (3,704 kg)
- **Gross weight:** 11,040 lb (5,008 kg)
- **Max takeoff weight:** 13,700 lb (6,214 kg)
- **Fuel capacity:** 356 US gallons (1,350 L; 296 imp gal)
- **Powerplant:** 2 × [General Electric J31-GE-5 centrifugal-flow turbojet](#) engines, 2,000 lbf (8.9 kN) thrust each

Performance

- **Maximum speed:** 413 mph (665 km/h, 359 kn) at 30,000 ft (9,100 m)
- **Cruise speed:** 375 mph (604 km/h, 326 kn)
- **Range:** 375 mi (604 km, 326 nmi)
- **Ferry range:** 950 mi (1,530 km, 830 nmi)
- **Service ceiling:** 46,200 ft (14,100 m)

- **Time to altitude:** 30,000 ft (9,100 m) in 15 minutes 30 seconds

Armament

- **Guns:**
 - 1 × 37 mm [M10 autocannon](#) with 44 rounds of ammunition
 - 3 × .50 cal [AN/M2 Browning heavy machine guns](#) with 200 rounds per gun
- **Rockets:**
 - 8 x 60lbs (27kg)
- **Bombs:**
 - 2 x 1000lbs (450kg) [AN-M65A1](#) or simply [Mark 65 bomb](#)



The North American P-51 Mustang is surely one of the most recognizable aircraft of World War II, thanks in large measure to the foresight of Lt. Col. Thomas J. Hitchcock Jr. When the US Army ruled that he was too young to enlist for military service at age 17, Hitchcock enlisted with the French Lafayette Flying Corps to serve in World War I.

2 / 15 Slides

- Before being shot down and captured by the German army early in his career, he had scored three aerial victories. Nothing if not resilient, Hitchcock would later escape from captivity and leap from a train in motion, then march over a hundred miles to Switzerland.

After the war, Hitchcock became a polo-playing member of high society, an investment banker, and a socialite, even being an inspiration for F. Scott Fitzgerald's character Tom Buchanan in "The Great Gatsby."

When World War II broke out, Hitchcock again went into service, this time securing a commission in the US Army Air Force. Though he wished to take command of a fighter squadron, at age 42 he was judged too old for combat roles.

Detached to London as Assistant Military Air Attaché, Hitchcock was to take significant influence in the development of the Mustang.





In April 1942, test pilot Ronald Hawker flew the Mustang-then fitted with an Allison engine-and though this aircraft showed very good performance at low and medium altitudes, he felt that the high altitude capabilities could be vastly improved with a Rolls-Royce Merlin 61 engine.

This hypothesis was immediately tested by the British, who fitted five Mustangs with the Merlin engine. Sure enough, the resultant speed topped well over 430 miles per hour at 30,000 nearly 100 miles per hour faster than the Allison-powered counterpart.

Hitchcock's subsequent report to Washington in the fall of 1942 recommended immediate development of the P-51A into a high-altitude fighter by replacing the Allison engine with the Merlin. He believed the Merlin-powered Mustang would prove the best fighter flying in 1943.

By now, the US Army Air Force had ordered 2,200 of the new P-51Bs mounted with the Merlin engines; later in the year, the 354th Fighter Group would be the very first combat unit in the European Theater of Operations to receive the new engines.

With its range extended by external wing tanks, the Mustang escorted B-17 and B-24 bombers deep into Germany, protecting the bomber crews in those planes with lethal precision.



By early 1944, with a greater sense of confidence, and an aggressive new air tactic, the Mustang started to turn the tide of the air war in favor of the Allies.

During "Big Week" in February of 1944, Mustang pilots destroyed 17 percent of the Luftwaffe's experienced fighter pilots in air-to-air combat.



This was the period when Hitchcock, Deputy Chief of Staff of the 9th Air Support Command, decided to tackle the problem. Later, he crashed the aircraft flying near Salisbury, England, in a test on April 18, 1944; he was killed.

Hitchcock would die without witnessing the complete impact the P-51 Mustang would have on achieving Allied air supremacy crucial factor in achieving success for the Normandy invasion, two months into the future.



North American P-51 Mustang

P-51 Mustang



P-51D nicknamed "Tika IV" of 361st Fighter Group with underwing [drop tanks](#)

General information

Type	Fighter
National origin	United States
Manufacturer	North American Aviation
Primary users	United States Army Air Forces Royal Air Force Royal New Zealand Air Force Royal Canadian Air Force
Number built	More than 15,000 ^[1]

History

Introduction date	January 1942 (RAF) ^[2]
First flight	26 October 1940 ^[3]

Retired	Retired from military service 1984 (Dominican Air Force) ^[4]
Variants	North American A-36 Rolls-Royce Mustang Mk.X CAC Mustang Cavalier Mustang
Developed into	North American F-82 Twin Mustang Piper PA-48 Enforcer

The **North American Aviation P-51 Mustang** is an American long-range, single-seat [fighter](#) and [fighter-bomber](#) used during [World War II](#) and the [Korean War](#), among other conflicts. The Mustang was designed in 1940 by a team headed by [James H. Kindelberger](#) of [North American Aviation](#) (NAA) in response to a requirement of the [British Purchasing Commission](#). The commission approached NAA to build [Curtiss P-40 fighters](#) under license for the [Royal Air Force](#) (RAF). Rather than build an old design from another company, NAA proposed the design and production of a more modern fighter. The prototype NA-73X [airframe](#) was completed on 9 September 1940, 102 days after contract signing, achieving its first flight on 26 October.^[5]

The Mustang was designed to use the [Allison V-1710](#) engine without an export-sensitive turbosupercharger^[6] or a multi-stage supercharger, resulting in limited high-altitude performance. The aircraft was first flown operationally and very successfully by the RAF and as a [tactical-reconnaissance aircraft](#) and fighter-bomber (Mustang Mk I). In mid 1942, a development project known as the [Rolls-Royce Mustang X](#), replaced the Allison engine with a [Rolls-Royce Merlin](#) 65 two-stage inter-cooled supercharged engine. During testing at [Rolls-Royce's airfield at Hucknall](#) in [England](#), it was clear the engine dramatically improved the aircraft's performance at altitudes above 15,000 ft (4,600 m) without sacrificing range.^[7] Following receipt of the test results and after further flights by a number of USAAF pilots, the results were so positive that North American began work on converting several aircraft developing into the P-51B/C (Mustang Mk III) model, which became the first long range fighter to be able to compete with the [Luftwaffe's](#) fighters.^[8] The definitive version, the [P-51D](#), was powered by the [Packard V-1650-7](#), a [license-built](#) version of the two-speed, two-stage-[supercharged Merlin 66](#), and was armed with six [.50 caliber](#) (12.7 mm) [AN/M2 Browning machine guns](#).^[9]

From late 1943, P-51Bs and P-51Cs (supplemented by P-51Ds from mid-1944) were used by the [USAAF's Eighth Air Force](#) to escort bombers in raids over [Germany](#), while the RAF's [Second Tactical Air Force](#) and the USAAF's [Ninth Air Force](#) used the Merlin-powered Mustangs as fighter-bombers, roles in which the Mustang helped ensure

Allied [air superiority](#) in 1944.^[10] The P-51 was also used by [Allied](#) air forces in the [North African, Mediterranean, Italian](#), and [Pacific](#) theaters. During World War II, Mustang pilots claimed to have destroyed 4,950 enemy aircraft.^[a]

At the start of the Korean War, the Mustang, by then redesignated **F-51**, was the main fighter of the United States until [jet fighters](#), including North American's [F-86 Sabre](#), took over this role; the Mustang then became a specialized fighter-bomber. Despite the advent of jet fighters, the Mustang remained in service with some air forces until the early 1980s. After the Korean War, Mustangs became popular civilian [warbirds](#) and [air racing](#) aircraft.

Design and development

[\[edit\]](#)

Main article: [North American P-51 Mustang variants](#)



North American NA-73X, with a short carburetor air-intake scoop and the frameless, rounded windshield: On the production Mustang Mk Is, the frameless windshield was replaced with a three-piece unit that incorporated a bullet-



resistant windshield. P-51D on the Ingleside assembly line

In 1938, the British government established a purchasing commission in the United States, headed by Sir [Henry Self](#).^{[12][13]} Self was given overall responsibility for RAF production, research, and development, and also served with Sir [Wilfrid Freeman](#), the Air Member for Development and Production. Self also sat on the British Air Council Subcommittee on Supply (or "Supply Committee"), and one of his tasks was to organize the manufacturing and supply of American fighter aircraft for the RAF. At the time, the choice was very limited, as no U.S. aircraft then in production or flying met European standards, with only the [Curtiss P-40 Tomahawk](#) coming close. The [Curtiss-Wright](#) plant was running at capacity, so P-40s were in short supply.^[14]

North American Aviation (NAA) was already supplying its [T-6 Texan](#) (known in British service as the "Harvard") trainer to the RAF, but was otherwise underused. NAA President "[Dutch](#)" [Kindelberger](#) approached Self to sell a new [medium bomber](#), the [North](#)

[American B-25 Mitchell](#). Instead, Self asked if NAA could manufacture P-40s [under license](#) from Curtiss. Kindelberger said NAA could have a better aircraft with the same [Allison V-1710](#) engine in the air sooner than establishing a production line for the P-40.

[John Attwood](#) of NAA spent much time from January to April 1940 at the British Purchasing Commission's offices in New York discussing the British specifications of the proposed aircraft with British engineers. The discussions consisted of free-hand conceptual drawings of an aircraft with the British officials. Self was concerned that NAA had not ever designed a fighter, insisting they obtain the drawings and study the wind-tunnel test results for the P-40, before presenting them with detailed design drawings based on the agreed concept. NAA purchased the drawings and data from Curtiss for £56,000, confirming the purchase with the British Purchasing Commission. The commission approved the resulting detailed design drawings, signing the commencement of the Mustang project on 4 May 1940, and firmly ordering 320 on 29 May 1940. Prior to this, NAA only had a letter of intent for an order of 320 aircraft. Curtiss engineers accused NAA of plagiarism.^[15]

The British Purchasing Commission stipulated armament of four [.303 in \(7.7 mm\)](#) machine guns (as used on the Tomahawk), a unit cost of no more than \$40,000, and delivery of the first production aircraft by January 1941.^[16] In March 1940, 320 aircraft were ordered by Freeman, who had become the executive head of the [Ministry of Aircraft Production](#) (MAP) and the contract was promulgated on 24 April.^[17]

The NA-73X, which was designed by a team led by lead engineer [Edgar Schmued](#), followed the best conventional practice of the era, designed for ease of mass manufacturing.^[15] The design included several new features.^[nb 1] One was a wing designed using [laminar flow](#) airfoils, which were developed co-operatively by NAA and the [National Advisory Committee for Aeronautics](#) (NACA). These airfoils generated low drag at high speeds.^{[18][b]} During the development of the NA-73X, a wind-tunnel test of two wings, one using NACA five-digit airfoils and the other using the new NAA/NACA 45–100 airfoils, was performed in the [University of Washington](#) Kirsten Wind Tunnel. The results of this test showed the superiority of the wing designed with the [NAA/NACA 45–100 airfoils](#).^{[20][nb 2]}



XP-51 41-039 is one of two Mustang Mk I aircraft handed over to the USAAC for testing

The other feature was a new cooling arrangement positioned aft (single ducted water and oil radiators assembly) that reduced the fuselage drag and effects on the wing. Later,^[22] after much development, they discovered that the cooling assembly could take advantage of the [Meredith effect](#), in which heated air exited the radiator with a slight

amount of [jet thrust](#). Because NAA lacked a suitable wind tunnel to test this feature, it used the [GALCIT](#) 3.0 m (10 ft) wind tunnel at the [California Institute of Technology](#). This led to some controversy over whether the Mustang's cooling system [aerodynamics](#) were developed by NAA's engineer Schmued or by Curtiss, as NAA had purchased the complete set of P-40 wind tunnel data and flight test reports.^{[23][24]} The NA-73X was also one of the first aircraft to have a fuselage [lofted](#) mathematically using [conic sections](#); this resulted in smooth, low-drag surfaces.^[25] To aid production, the airframe was divided into five main sections—forward, center, rear fuselage, and two wing halves—[all of which](#) were fitted with wiring and piping before being joined.^[25]

The prototype NA-73X was rolled out in September 1940, just 102 days after the order had been placed; it first flew on 26 October 1940, 149 days into the contract, an uncommonly short development period even during the war.^[26] With test pilot [Vance Breese](#) at the controls,^[27] the prototype handled well and accommodated an impressive fuel load. The aircraft's three-section, [semi-monocoque](#) fuselage was constructed entirely of aluminum to save weight. It was armed with four .30 caliber (7.62 mm) [AN/M2 Browning machine guns](#) in the wings and two .50 caliber (12.7 mm) [AN/M2 Browning machine guns](#) mounted under the engine and firing through the propeller arc using a [gun-synchronizing gear](#).^[nb 3]

While the USAAC could block any sales it considered detrimental to the interests of the US, the NA-73 was considered to be a special case because it had been designed at the behest of the British and all dealings were directly between the BPC and NAA, and did not involve the US Army or Wright Field in any way. In September 1940, a further 300 NA-73s were ordered by the MAP.^[16] To ensure uninterrupted delivery, Colonel [Oliver P. Echols](#) arranged with the Anglo-French Purchasing Commission to deliver the aircraft and NAA gave two examples (41-038 and 41-039) to the USAAC for evaluation.^{[28][nb 4]}

It is important to note that the Mustang I (NA-73 and NA-83) and the Ia (NA-91), produced for the British, were not equivalent to the P-51A which was a later model (NA-99). Two British Mustang Is were held back by the USAAF and given the provisional model number XP-51. The USAAF held back 57 Mustang Ia aircraft armed with 4 x 20mm Hispano cannon, from the third British order, converting most of them to tactical reconnaissance aircraft and designating them P-51-2/F6A. North American retained the second aircraft of this batch to help develop the P-51A.^[30]

The Allison engine in the Mustang I had a single-stage supercharger that caused power to drop off rapidly above 15,000 feet (4,600 m). This made it unsuitable for use at the altitudes where combat was taking place in Europe. Allison's attempts at developing a high-altitude engine were underfunded, but produced the V-1710-45, which featured a variable-speed auxiliary supercharger and developed 1,150 horsepower (860 kW) at 22,400 feet (6,800 m). In November 1941, NAA studied the possibility of using it, but fitting its excessive length in the Mustang would require extensive airframe modifications and cause long production delays.^{[31][32]} In May 1942, following positive reports from the RAF on the Mustang I's performance below 15,000 ft, Ronald Harker, a test pilot for [Rolls-Royce](#), suggested fitting a [Merlin 61](#), as fitted to the [Spitfire Mk](#)

[IX](#).^[31] The Merlin 61 had a two-speed, two-stage, intercooled supercharger, designed by [Stanley Hooker](#) of Rolls-Royce.^[33] Both the Merlin 61 and V-1710-39 were capable of about 1,570 horsepower (1,170 kW) [war emergency power](#) at relatively low altitudes, but the Merlin developed 1,390 horsepower (1,040 kW) at 23,500 feet (7,200 m) versus the Allison's 1,150 horsepower (860 kW) at 11,800 feet (3,600 m),^{[34][35][32]} delivering an increase in top speed from 390 mph (340 kn; 630 km/h) at ~15,000 feet (4,600 m) to an estimated 440 mph (380 kn; 710 km/h) at 28,100 feet (8,600 m). In the end the Merlin 61 was never fitted to the Mustang X, (or any other Mustang). The 65 series (a medium altitude engine) was fitted to all Mustang X prototypes.^[36]

Initially, the Mustang's steadfast champion, USAAC/F Assistant Air Attaché Major Thomas Hitchcock, was concerned that the USAAF had little or no interest in the potential of the P-51A and its development with the Merlin engine. He wrote: "Its development in this theatre has suffered for various reasons. Sired by the English out of an American mother, the Mustang has no parent in the Army Air Corps to appreciate and push its good points. It does not fully satisfy good people on both sides of the Atlantic who seem more interested in pointing with pride to the development of a 100% national product..."^[37]

Nevertheless, during the British service development program of the Mustang I at [Rolls-Royce's airfield at Hucknall](#), a close relationship was developed between NAA, the RAF Air Fighting Development Unit and Rolls Royce Rolls-Royce Flight Test Establishment at Hucknall.

Following extensive communication between Hitchcock (based in England), Rolls Royce engineers and Phillip Legarra at NAA regarding the promising outlook of a Merlin Mustang, along with the subsequent work in progress by Rolls Royce on the Mustang X, NAA representatives including Mustang designer Schmued visited the UK to examine and discuss the project in detail.^[38]

The promising calculations and modification progress by Rolls Royce led in July 1942 to a contract being let for two NAA Merlin prototypes, briefly designated XP-78, but soon to become the XP-51B.^[39] Based on the Packard V-1650-3 duplicating the Merlin 61's performance, NAA estimated for the XP-78 a top speed of 445 mph (387 kn; 716 km/h) at 28,000 feet (8,500 m), and a service ceiling of 42,000 feet (13,000 m).^[31]

Initial flights of what was known to Rolls-Royce as the [Mustang X](#) were completed at Hucknall in October 1942.^[31]

The first flight of the US version, designated XP-51B took place in November 1942, but the USAAF had become so interested in the Merlin Mustang project that an initial contract for 400 aircraft was placed three months beforehand in August.^[40] The conversion led to production of the P-51B beginning at NAA's Inglewood, California, plant in June 1943,^[41] and P-51s started to become available to the 8th and [9th air forces](#) in the winter of 1943–1944. Conversion to the two-stage supercharged and intercooled Merlin 60 series, over 350 lb (160 kg) heavier than the single-stage Allison, driving a four-bladed Hamilton Standard propeller, required moving the wing slightly

forward to correct the aircraft's [center of gravity](#). After the USAAF, in July 1943, directed fighter aircraft manufacturers to maximize internal fuel capacity, NAA calculated the P-51B's center of gravity to be forward enough to include an additional 85 US gal (320 L; 71 imp gal) fuel tank in the fuselage behind the pilot, greatly increasing the aircraft's range over that of the earlier P-51A. NAA incorporated the tank in the production of the P-51B-10, and supplied kits to retrofit it to all existing P-51Bs.^[31]

Operational history

[\[edit\]](#)

United Kingdom operational service

[\[edit\]](#)



A Royal Air Force North American Mustang Mk III (FX908) on the ground at [Hucknall](#)

The Mustang was initially developed for the RAF, which was its first user. As the first Mustangs were built to British requirements, these aircraft used factory numbers and were not P-51s; the order comprised 320 NA-73s, followed by 300 NA-83s, all of which were designated Mustang Mark I by the RAF.^[42] The first RAF Mustangs supplied under [Lend-Lease](#) were 93 Mk Ia designated as P-51s by the USAAF, followed by 50 P-51As used as Mustang Mk IIs.^[43] Aircraft supplied to Britain under Lend-Lease were required for accounting purposes to be on the [USAAC's](#) books before they could be supplied to Britain, but the British Aircraft Purchasing Commission signed its first contract for the North American NA-73 on 24 April 1940, before Lend-Lease was in effect. Thus, the initial order for the P-51 Mustang (as it was later known) was placed by the British under the "[cash and carry](#)" program, as required by the US Neutrality Acts of the 1930s.^[citation needed]

After the arrival of the initial aircraft in the UK in October 1941, the first squadron of Mustang Mk Is entered service in January 1942, the first being [No. 26 Squadron RAF](#).^[44] Due to poor high-altitude performance, the Mustangs were used by [Army Co-operation Command](#), rather than Fighter Command, and were used for tactical reconnaissance and ground-attack duties. On 10 May 1942, Mustangs first flew over France, near [Berck-sur-Mer](#).^[45] On 27 July 1942, 16 RAF Mustangs undertook their first long-range reconnaissance mission over Germany. During the amphibious [Dieppe Raid](#) on the French coast (19 August 1942), four British and Canadian Mustang squadrons, including 26 Squadron, saw action covering the assault on the ground. By 1943–1944, British Mustangs were used extensively to seek out [V-1 flying bomb](#) sites. The last RAF Mustang Mk I and Mustang Mk II aircraft were struck off charge in 1945.

Army Co-operation Command used the Mustang's superior speed and long range to conduct low-altitude "[Rhubarb](#)" raids over continental Europe, sometimes penetrating

German airspace. The V-1710 engine ran smoothly at 1,100 rpm, versus 1,600 for the Merlin, enabling long flights over water at 50 ft (15 m) altitude before approaching the enemy coastline. Over land, these flights followed a zig-zag course, turning every six minutes to foil enemy attempts at plotting an interception. During the first 18 months of Rhubarb raids, RAF Mustang Mk.IIs and Mk.IIs destroyed or heavily damaged 200 locomotives, over 200 canal barges, and an unknown number of enemy aircraft parked on the ground, for a loss of eight Mustangs. At sea level, the Mustangs were able to outrun all enemy aircraft encountered.^[46] The RAF gained a significant performance enhancement at low altitude by removing or resetting the engine's manifold pressure regulator to allow overboosting, raising output as high as 1,780 horsepower at 70 in Hg.^{[46][34]} In December 1942, Allison approved only 1,570 horsepower at 60 in Hg manifold pressure for the V-1710-39.^[34]

The RAF later operated 308 P-51Bs and 636 P-51Cs,^[47] which were known in RAF service as Mustang Mk IIIs; the first units converted to the type in late 1943 and early 1944. Mustang Mk III units were operational until the end of World War II, though many units had already converted to the Mustang Mk IV (P-51D) and Mk IVa (P-51K) (828 in total, comprising 282 Mk IV and 600 Mk IVa).^[48] As all except the earliest aircraft were obtained under Lend-Lease, all Mustang aircraft still on RAF charge at the end of the war were either returned to the USAAF "on paper" or retained by the RAF for scrapping. The last RAF Mustangs were retired from service in 1947.^[49]

U.S. operational service

[\[edit\]](#)

Prewar theory

[\[edit\]](#)

Prewar doctrine was based on the idea "[the bomber will always get through](#)".^[50] Despite RAF and Luftwaffe experience with daylight bombing, the USAAF still incorrectly believed in 1942 that [tightly packed formations of bombers](#) would have so much firepower that they could fend off fighters on their own.^[50] Fighter escort was a low priority, but when the concept was discussed in 1941, the [Lockheed P-38 Lightning](#) was considered to be most appropriate, as it had the speed and range. Another school of thought favored a [heavily up-armed "gunship" conversion of a strategic bomber](#).^[51] A single-engined, high-speed fighter with the range of a bomber was thought to be an engineering impossibility.^[52]

Eighth Air Force bomber operations 1942–1943

[\[edit\]](#)



P-51 Mustangs of the [375th Fighter Squadron](#), [Eighth Air Force](#) mid-1944

The [8th Air Force](#) started operations from Britain in August 1942. At first, because of the limited scale of operations, no conclusive evidence showed American doctrine was failing. In the 26 operations flown to the end of 1942, the loss rate had been under 2%.^[53]

In January 1943, at the [Casablanca Conference](#), the Allies formulated the [Combined Bomber Offensive](#) (CBO) plan for "round-the-clock" bombing – USAAF daytime operations complementing the RAF nighttime raids on industrial centers. In June 1943, the [Combined Chiefs of Staff](#) issued the [Pointblank Directive](#) to destroy the Luftwaffe's capacity before the planned invasion of Europe, putting the CBO into full implementation. German daytime fighter efforts were, at that time, focused on the Eastern Front and several other distant locations. Initial efforts by the 8th met limited and unorganized resistance, but with every mission, the Luftwaffe moved more aircraft to the west and quickly improved their battle direction. In fall 1943, the 8th Air Force's heavy bombers conducted a series of deep-penetration raids into Germany, beyond the range of escort fighters. The [Schweinfurt–Regensburg mission](#) in August lost 60 B-17s of a force of 376, the [14 October attack](#) lost 77 of a force of 291—26% of the attacking force.^[54]

For the US, the very concept of self-defending bombers was called into question, but instead of abandoning daylight raids and turning to night bombing, as the RAF suggested, they chose other paths; at first, bombers converted to gunships (the [Boeing YB-40](#)) were believed to be able to escort the bomber formations, but when the concept proved to be unsuccessful, thoughts then turned to the Lockheed P-38 Lightning.^[55] In early 1943, the USAAF also decided that the [Republic P-47 Thunderbolt](#) and P-51B be considered for the roles of smaller escort fighters, and in July, a report stated that the P-51B was "the most promising plane" with an endurance of 4 hours 45 minutes with the standard internal fuel of 184 gallons plus 150 gallons carried externally.^[56] In August, a P-51B was fitted with an extra internal 85-gallon tank, but problems with longitudinal stability occurred, so some compromises in performance with the full tank were made. Since the fuel from the fuselage tank was used during the initial stages of a mission, the fuel tank would be fitted in all Mustangs destined for [VIII Fighter Command](#).^[57]

P-51 introduction

[\[edit\]](#)

The P-51 Mustang was a solution to the need for an effective bomber escort. It used a common, reliable engine and had internal space for a larger-than-average fuel load. With external fuel tanks, it could accompany the bombers from England to Germany and back.^[58]

By the time the Pointblank offensive resumed in early 1944, matters had changed. Bomber escort defenses were initially layered, using the shorter-range P-38s and P-47s to escort the bombers during the initial stages of the raid before handing over to the P-51s when they were forced to turn for home. This provided continuous coverage during the raid. The Mustang was so clearly superior to earlier US designs that the 8th Air Force began to steadily switch its fighter groups to the Mustang, first swapping arriving P-47 groups to the 9th Air Force in exchange for those that were using P-51s, then gradually converting its Thunderbolt and Lightning groups. By the end of 1944, 14 of its 15 groups flew Mustangs.^[59]

The Luftwaffe's twin-engined [Messerschmitt Bf 110](#) heavy fighters brought up to deal with the bombers proved to be easy prey for the Mustangs, and had to be quickly withdrawn from combat. The [Focke-Wulf Fw 190A](#), already suffering from poor high-altitude performance, was outperformed by the Mustang at the B-17's altitude, and when laden with [heavy bomber-hunting weapons](#) as a replacement for the more vulnerable twin-engined *Zerstörer* heavy fighters, it suffered heavy losses. The [Messerschmitt Bf 109](#) had comparable performance at high altitudes, but its lightweight airframe was even more greatly affected by increases in armament. The Mustang's much lighter armament, tuned for antifighter combat, allowed it to overcome these single-engined opponents.^[citation needed]

Fighting the *Luftwaffe*

[\[edit\]](#)



Pilots of the all-Black American [332nd Fighter Group](#) (the [Tuskegee Airmen](#)) at Ramitelli, Italy: From left, Lt. [Dempsey W. Morgran](#), Lt. [Carroll S. Woods](#), Lt. [Robert H. Nelron, Jr.](#), Capt. [Andrew D. Turner](#), and Lt. [Clarence D. Lester](#)

At the start of 1944, Major General [James Doolittle](#), the new commander of the 8th Air Force, released most fighters from the requirement of flying in close formation with the bombers, allowing them free rein to attack the Luftwaffe wherever it could be found. The aim was to achieve [air supremacy](#). Mustang groups were sent far ahead of the bombers in a "fighter sweep" to intercept German fighters. Bomber crews complained, but by June, supremacy was achieved.^[60]

The *Luftwaffe* answered with the *Gefechtsverband* ("battle formation"). This consisted of a *Sturmgruppe* of heavily armed and armored Fw 190As escorted by two *Begleitgruppen* of Bf 109s, whose task was to keep the Mustangs away from the Fw 190s as they attacked the bombers. This strategy proved to be problematic, as the large German formation took a long time to assemble and was difficult to maneuver. It was often intercepted by the P-51 "fighter sweeps" before it could attack the bombers. However, German attacks against bombers could be effective when they did occur; the bomber-destroyer Fw 190As swept in from astern and often pressed their attacks to within 90 m (100 yd).^[61]



A USAAF armorer of the [100th Fighter Squadron](#), [332nd Fighter Group](#), 15th U.S. Air Force checks ammunition belts of the .50 caliber (12.7 mm) Browning machine guns in the wings of a North American P-51B Mustang in Italy, circa September 1944

While not always able to avoid contact with the escorts, the threat of mass attacks and later the "company front" (eight abreast) assaults by armored *Sturmgruppe* Fw 190As brought an urgency to attacking the *Luftwaffe* wherever it could be found, either in the air or on the ground. Beginning [in late February 1944](#), 8th Air Force fighter units began systematic strafing attacks on German airfields with increasing frequency and intensity throughout the spring, with the objective of gaining air supremacy over the [Normandy](#) battlefield. In general, these were conducted by units returning from escort missions, but beginning in March, many groups also were assigned airfield attacks instead of bomber support. The P-51, particularly with the advent of the K-14 [gyro gunsight](#) and the development of "Clobber Colleges"^[62] for the training of fighter pilots in fall 1944, was a decisive element in Allied countermeasures against the *Jagdverbände*.

The numerical superiority of the USAAF fighters, superb flying characteristics of the P-51, and pilot proficiency helped cripple the *Luftwaffe*'s fighter force. As a result, the fighter threat to the US, and later British, bombers was greatly diminished by July 1944. The RAF, long proponents of night bombing for protection, were able to reopen daylight bombing in 1944 as a result of the crippling of the *Luftwaffe* fighter arm. [Reichsmarschall Hermann Göring](#), commander of the *Luftwaffe* during the war, was quoted as saying, "When I saw Mustangs over Berlin, I knew the jig was up."^{[63][64][58]}

Beyond Pointblank

[\[edit\]](#)



P-51D 44-14888 of the 8th AF/357th FG/363rd FS, named *Glamorous Glen III*, is the aircraft in which [Chuck Yeager](#) achieved most of his 12.5 kills, including two Me 262s – shown here with twin single-use 108-gallon (409-l) drop tanks fitted. This aircraft was renamed "Melody's Answer" and crashed on Mar 2, 1945, from unknown causes at Haseloff, west of Treuenbrietzen, Germany.



Top-scoring Mustang ace of WWII, Major [George Earl Preddy Jr.](#), with 26.83 aerial victories and five aircraft destroyed on the ground (first three victories were achieved on [P-47](#))

On 15 April 1944, VIII Fighter Command began "Operation Jackpot", attacks on Luftwaffe fighter airfields. As the efficacy of these missions increased, the number of fighters at the German airbases fell to the point where they were no longer considered worthwhile targets. On 21 May, targets were expanded to include railways, locomotives, and other [rolling stock](#) used by the Germans to transport materiel and troops, in missions dubbed "Chattanooga".^[65] The P-51 excelled at this mission, although losses were much higher on strafing missions than in air-to-air combat, partially because the Mustang's liquid-cooled engine (particularly its liquid coolant system) was vulnerable to small-arms fire, unlike the air-cooled [R-2800](#) radials of its Republic P-47 Thunderbolt stablemates based in England, regularly tasked with ground-strafing missions.^{[[citation needed](#)]}



P-51D Mustang *Detroit Miss* of the 375th Fighter Squadron: [Urban L. Drew](#) flew this aircraft in the autumn 1944 and shot down six German aircraft, including two jet-powered [Me 262s](#) in a single mission.

Given the overwhelming Allied [air superiority](#), the Luftwaffe put its effort into the development of aircraft of such high performance that they could operate with impunity, but which also made bomber attack much more difficult, merely from the flight velocities they achieved. Foremost among these were the [Messerschmitt Me 163B](#) point-defense rocket interceptors, which started their operations with [JG 400](#) near the end of July 1944,

and the longer-endurance [Messerschmitt Me 262](#)A jet fighter, first flying with the [Gruppe](#)-strength [Kommando Nowotny](#) unit by the end of September 1944. In action, the Me 163 proved to be [more dangerous to the Luftwaffe](#) than to the Allies and was never a serious threat. The Me 262A was a serious threat, but attacks on their airfields neutralized them. The pioneering [Junkers Jumo 004 axial-flow jet engines](#) of the Me 262As needed careful nursing by their pilots, and these aircraft were particularly vulnerable during takeoff and landing.^[66] Lt. [Chuck Yeager](#) of the [357th Fighter Group](#) was one of the first American pilots to shoot down an Me 262, which he caught during its landing approach. On 7 October 1944, Lt. [Urban L. Drew](#) of the [361st Fighter Group](#) shot down two Me 262s that were taking off, while on the same day, Lt. Col. [Hubert Zemke](#), who had transferred to the Mustang-equipped [479th Fighter Group](#), shot down what he thought was a Bf 109, only to have his gun camera film reveal that it may have been an Me 262.^[67] On 25 February 1945, Mustangs of the [55th Fighter Group](#) surprised an entire [Staffel](#) of Me 262As at takeoff and destroyed six jets.^[68]

The Mustang also proved useful against the [V-1s](#) launched toward London. P-51B/Cs, using 150-octane fuel, were fast enough to catch the V-1 and operated in concert with shorter-range aircraft such as advanced marks of the [Supermarine Spitfire](#) and [Hawker Tempest](#).^[citation needed]

By 8 May 1945,^[69] the [8th](#), [9th](#), and [15th Air Force](#)'s P-51 groups ^[nb.5] claimed some 4,950 aircraft shot down (about half of all USAAF claims in the European theater, the most claimed by any Allied fighter in air-to-air combat)^[69] and 4,131 destroyed on the ground. Losses were about 2,520 aircraft.^[70] The 8th Air Force's [4th Fighter Group](#) was the top-scoring fighter group in Europe, with 1,016 enemy aircraft claimed destroyed. This included 550 claimed in aerial combat and 466 on the ground.^[citation needed]

In air combat, the top-scoring P-51 units (both of which exclusively flew Mustangs) were the 357th Fighter Group of the 8th Air Force with 565 air-to-air combat victories and the 9th Air Force's 354th Fighter Group with 664, which made it one of the top-scoring fighter groups. The top Mustang ace was the USAAF's [George Preddy](#), whose final tally stood at 26.83 victories (a number that includes shared one half- and one third victory credits), 23 of which were scored with the P-51. Preddy was shot down and killed by [friendly fire](#) on Christmas Day 1944 during the [Battle of the Bulge](#).^[69]

In China and the Pacific Theater

[\[edit\]](#)



A P-51 Mustang taking off from [Iwo Jima](#)

In early 1945, P-51C, D, and K variants also joined the [Chinese Nationalist Air Force](#). These Mustangs were provided to the 3rd, 4th, and 5th Fighter Groups and used to attack Japanese targets in occupied areas of China. The P-51 became the most capable fighter in China, while the [Imperial Japanese Army Air Force](#) used the [Nakajima Ki-84 Hayate](#) against it. ^{[[citation needed](#)]}

The P-51 was a relative latecomer to the Pacific theater, due largely to the need for the aircraft in Europe, although the P-38's twin-engined design was considered a safety advantage for long, over-water flights. The first P-51s were deployed in the Far East later in 1944, operating in close-support and escort missions, as well as tactical photoreconnaissance. As the war in Europe wound down, the P-51 became more common. With the [capture of Iwo Jima](#), USAAF P-51 Mustang fighters of the VII Fighter Command were stationed on that island starting in March 1945, being initially tasked with escorting [Boeing B-29 Superfortress](#) missions [against the Japanese homeland](#). ^{[[citation needed](#)]}

The command's last major raid of May was a daylight incendiary attack on Yokohama on 29 May conducted by 517 B-29s escorted by 101 P-51s. This force was intercepted by 150 [A6M Zero](#) fighters, sparking an intense air battle in which five B-29s were shot down and another 175 damaged. In return, the P-51 pilots claimed 26 "kills" and 23 "probables" for the loss of three fighters. The 454 B-29s that reached Yokohama struck the city's main business district and destroyed 6.9 square miles (18 km²) of buildings; over 1000 Japanese were killed.^{[[71](#)][[72](#)]} Overall, the attacks in May destroyed 94 square miles (240 km²) of buildings, which was equivalent to one-seventh of Japan's total urban area. The [minister of home affairs](#), [Iwao Yamazaki](#), concluded after these raids that Japan's civil defense arrangements were "considered to be futile".^{[[73](#)]} On the first day of June, 521 B-29s escorted by 148 P-51s were dispatched in a daylight raid against Osaka. While en route to the city, the Mustangs flew through thick clouds, and 27 of the fighters were destroyed in collisions. Nevertheless, 458 heavy bombers and 27 P-51s reached the city, and the bombardment killed 3,960 Japanese and destroyed 3.15 square miles (8.2 km²) of buildings. On 5 June, 473 B-29s struck Kobe by day and destroyed 4.35 square miles (11.3 km²) of buildings for the loss of 11 bombers. A force of 409 B-29s attacked Osaka again on 7 June; during this attack, 2.21 square miles (5.7 km²) of buildings were burnt out and the Americans did not suffer any losses. Osaka was bombed for the fourth time that month, on 15 June, when 444 B-29s destroyed 1.9 square miles (4.9 km²) of the city and another 0.59 square miles (1.5 km²)

of nearby [Amagasaki](#); 300,000 houses were destroyed in Osaka.^{[74][75]} This attack marked the end of the first phase of XXI Bomber Command's attack on Japan's cities. During May and June, the bombers had destroyed much of the country's six largest cities, killing between 112,000 and 126,762 people and rendering millions homeless. The widespread destruction and high number of casualties from these raids caused many Japanese to realize that their country's military was no longer able to defend the home islands. American losses were low compared to Japanese casualties; 136 B-29s were downed during the campaign.^{[76][77][78]} In Tokyo, Osaka, Nagoya, Yokohama, Kobe, and Kawasaki, "over 126,762 people were killed ... and a million and a half dwellings and over 105 square miles (270 km²) of urban space were destroyed."^[79] In Tokyo, Osaka and Nagoya, "the areas leveled (almost 100 square miles (260 km²)) exceeded the areas [destroyed](#) in all [German](#) cities by both the [American](#) and [British air forces](#) (about 79 square miles (200 km²))."^[79]

P-51s also conducted a series of independent ground-attack missions against targets in the home islands.^[80] The first of these operations took place on 16 April, when 57 P-51s strafed [Kanoya Air Field](#) in Kyushu.^[81] In operations conducted between 26 April and 22 June, the American fighter pilots claimed the destruction of 64 Japanese aircraft and damage to another 180 on the ground, as well as a further 10 shot down in flight; these claims were lower than the American planners had expected, however, and the raids were considered unsuccessful. USAAF losses were 11 P-51s to enemy action and seven to other causes.^[82]

Due to the lack of Japanese air opposition to the American bomber raids, VII Fighter Command was solely tasked with ground-attack missions from July. These raids were frequently made against airfields to destroy aircraft being held in reserve to attack the expected Allied invasion fleet. While the P-51 pilots only occasionally encountered Japanese fighters in the air, the airfields were protected by antiaircraft batteries and [barrage balloons](#).^[83] By the end of the war, VII Fighter Command had conducted 51 ground-attack raids, of which 41 were considered successful. The fighter pilots claimed to have destroyed or damaged 1,062 aircraft and 254 ships, along with large numbers of buildings and railway rolling stock. American losses were 91 pilots killed and 157 Mustangs destroyed.^[84]

Medal of Honor recipients

[\[edit\]](#)



Medal of Honor recipient Lt. Col. James H. Howard, in the cockpit of his P-51 Mustang

Two P-51 pilots received the [Medal of Honor](#) during World War II:

- USAAF Lt Col. [James H. Howard](#) of the [356th Fighter Squadron](#), [354th Fighter Group](#) was awarded the Medal of Honor for his action during a bomber escort mission near [Oschersleben](#), Germany on 11 January 1944, flying P-51B, serial number 43-6315 nicknamed "Ding Hao".^[85] Despite being outnumbered, Howard shot down three German planes and continued to defend the bombers even when his guns went out of action and fuel supply became dangerously low.^[86]
- USAAF Maj. [William A. Shomo](#) of the [82nd Reconnaissance Squadron](#), [71st Reconnaissance Group](#) was awarded the Medal of Honor for his action during a mission over [Luzon, Philippines](#) on 11 January 1945, flying an F-6D, the armed photo reconnaissance variant of the P-51, serial number 44-14841 nicknamed "Snooks the 5th". On that mission, Shomo shot down seven Japanese planes and became an "[ace in a day](#)".^[87]

Pilot observations

[\[edit\]](#)

Chief Naval Test Pilot and C.O. Captured Enemy Aircraft Flight Capt. [Eric Brown](#), [RN](#), tested the Mustang at [RAE Farnborough](#) in March 1944 and noted:

The Mustang was a good fighter and the best escort due to its incredible range, make no mistake about it. It was also the best American dogfighter. But the laminar-flow wing fitted to the Mustang could be a little tricky. It could not by any means out-turn a Spitfire. No way. It had a good rate-of-roll, better than the Spitfire, so I would say the plusses to the Spitfire and the Mustang just about equate. If I were in a dogfight, I'd prefer to be flying the Spitfire. The problem was I wouldn't like to be in a dogfight near Berlin, because I could never get home to Britain in a Spitfire!^[88]

The U.S. Air Forces, Flight Test Engineering, assessed the Mustang B on 24 April 1944 thus:

The rate of climb is good and the high speed in level flight is exceptionally good at all altitudes, from sea level to 40,000 feet. The airplane is very maneuverable with good controllability at indicated speeds up to 400 MPH [sic]. The stability about all axes is good and the rate of roll is excellent; however, the radius of turn is fairly large for a fighter. The cockpit layout is excellent, but visibility is poor on the ground and only fair in level flight.^[89]

[Kurt Bühligen](#), the third-highest scoring German fighter pilot of World War II's Western Front (with 112 confirmed victories, three against Mustangs), later stated:

We would out-turn the P-51 and the other American fighters, with the Bf 109 or the Fw 190. Their turn rate was about the same. The P-51 was faster than us, but our munitions and [cannon](#) were better.^[90]

German fighter ace [Heinz Bär](#) said that the P-51:

was perhaps the most difficult of all Allied aircraft to meet in combat. It was fast, maneuverable, hard to see, and difficult to identify because it resembled the Me 109.^[91]

After World War II

[\[edit\]](#)



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[USS Boxer](#) loads 146 [USAF](#) F-51Ds at [Alameda](#) for the Korean theater, in July 1950.

In the aftermath of World War II, the USAAF consolidated much of its wartime combat force and selected the P-51 as a "standard" piston-engined fighter, while other types, such as the P-38 and P-47, were withdrawn or given substantially reduced roles. As the more advanced ([P-80](#) and [P-84](#)) jet fighters were introduced, the P-51 was also relegated to secondary duties.^[92]

In 1947, the newly formed [USAF Strategic Air Command](#) employed Mustangs alongside F-6 Mustangs and [F-82 Twin Mustangs](#), due to their range capabilities. In 1948, the designation P-51 (P for pursuit) was changed to *F-51* (*F* for fighter) and the existing *F* designator for photographic reconnaissance aircraft was dropped because of a new designation scheme throughout the USAF. Aircraft still in service in the USAF or [Air National Guard](#) (ANG) when the system was changed included: *F-51B*, *F-51D*, *F-51K*, *RF-51D* (formerly *F-6D*), *RF-51K* (formerly *F-6K*) and *TRF-51D* (two-seat trainer conversions of F-6Ds). They remained in service from 1946 through 1951. By 1950, although Mustangs continued in service with the USAF after the war, the majority of the USAF's Mustangs had become surplus to requirements and placed in storage, while some were transferred to the [Air Force Reserve](#) and the ANG.^[1]



An F-51 Mustang, laden with bombs and rockets, taxis through a puddle at an airbase in Korea.

From the start of the [Korean War](#), the Mustang once again proved useful. A "substantial number" of stored or in-service F-51Ds were shipped, via aircraft carriers, to the combat zone, and were used by the USAF, the South African Air Force, and the [Republic of Korea Air Force](#) (ROKAF). The F-51 was used for ground attack, fitted with rockets and bombs, and photo reconnaissance, rather than being as interceptors or "pure" fighters, where it was already surpassed by early jets. After the first North Korean invasion, USAF units were forced to fly from bases in Japan and the F-51Ds, with their long range and endurance, could attack targets in Korea that short-ranged F-80 jets could not. Because of the vulnerable liquid cooling system, however, the F-51s sustained heavy losses to ground fire.^[93] Due to its lighter structure and a shortage of spare parts, the newer, faster F-51H was not used in Korea.^[citation needed] On August 5, 1950, Major [Louis J. Sebill](#) of the [67th Fighter-Bomber Squadron](#) attacked a North Korean armored column advancing on [United Nations military units](#) during the [Battle of Pusan Perimeter](#). Though his aircraft was heavily damaged and he was wounded during the first pass on the column, he turned his F-51 around and deliberately crashed into the convoy at the cost of his life, and was posthumously awarded the Medal of Honor.^[94]

Mustangs continued flying with USAF and ROKAF fighter-bomber units on close support and interdiction missions in Korea until 1953 when they were largely replaced as fighter-bombers by USAF F-84s and by [United States Navy](#) (USN) [Grumman F9F Panthers](#). Other air forces and units using the Mustang included the [Royal Australian Air Force's 77 Squadron](#), which flew Australian-built Mustangs as part of [British Commonwealth Forces Korea](#). The Mustangs were replaced by [Gloster Meteor](#) F8s in 1951. The [South African Air Force's 2 Squadron](#) used U.S.-built Mustangs as part of the [U.S. 18th Fighter Bomber Wing](#) and had suffered heavy losses by 1953, after which 2 Squadron converted to the F-86 Sabre.^[citation needed]

F-51s flew in the [Air Force Reserve](#) and ANG throughout the 1950s. The last American USAF Mustang was F-51D-30-NA AF serial no. 44-74936, which was finally withdrawn from service with the [West Virginia Air National Guard's 167th Fighter Interceptor Squadron](#) in January 1957 and retired to what was then called the Air Force Central Museum,^[95] although it was briefly reactivated to fly at the 50th anniversary of the Air Force Aerial Firepower Demonstration at the Air Proving Ground, [Eglin AFB](#), Florida, on 6 May 1957.^[96] This aircraft, painted as P-51D-15-NA serial no. 44-15174, is on display at the [National Museum of the United States Air Force](#), [Wright-Patterson AFB](#), in [Dayton, Ohio](#).^{[97][page needed]}



West Virginia Air National Guard F-51D with postwar "uncuffed" propeller unit

The final withdrawal of the Mustang from USAF dumped hundreds of P-51s onto the civilian market. The rights to the Mustang design were purchased from North American by the [Cavalier Aircraft](#) Corporation, which attempted to market the surplus Mustang

aircraft in the U.S. and overseas. In 1967 and again in 1972, the USAF procured batches of remanufactured Mustangs from Cavalier, most of them destined for air forces in South America and Asia that were participating in the [Military Assistance Program](#) (MAP). These aircraft were remanufactured from existing original F-51D airframes fitted with new V-1650-7 engines, a new radio, tall F-51H-type vertical tails, and a stronger wing that could carry six 13 mm (0.50 in) machine guns and a total of eight underwing hardpoints. Two 1,000-pound (450 kg) bombs and six 130 mm (5 in) rockets could be carried. They all had an original F-51D-type canopy but carried a second seat for an observer behind the pilot. One additional Mustang was a two-seat, dual-control TF-51D (67-14866) with an enlarged canopy and only four wing guns. Although these remanufactured Mustangs were intended for sale to South American and Asian nations through the MAP, they were delivered to the USAF with full USAF markings. They were, however, allocated new serial numbers (67-14862/14866, 67-22579/22582 and 72-1526/1541).^[97][\[page needed\]](#)

The last U.S. military use of the F-51 was in 1968 when the U. S. Army employed a vintage F-51D (44-72990) as a chase aircraft for the [Lockheed YAH-56 Cheyenne](#) armed helicopter project. This aircraft was so successful that the Army ordered two F-51Ds from Cavalier in 1968 for use at [Fort Rucker](#) as chase planes. They were assigned the serials 68-15795 and 68-15796. These F-51s had wingtip fuel tanks and were unarmed. Following the end of the Cheyenne program, these two chase aircraft were used for other projects. One of them (68-15795) was fitted with a 106 mm recoilless rifle for evaluation of the weapon's value in attacking fortified ground targets.^[98] Cavalier Mustang 68-15796 survives at the [Air Force Armament Museum](#), [Eglin AFB](#), Florida, displayed indoors in World War II markings.

The F-51 was adopted by many foreign air forces and continued to be an effective fighter into the mid-1980s with smaller air arms. The last Mustang ever downed in battle occurred during [Operation Power Pack](#) in the [Dominican Republic](#) in 1965, with the last aircraft finally being retired by the [Dominican Air Force](#) in 1984.^[99]



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US Navy splits from Air Force in future fighter jet program



One of the visualizations of the F/A-XX aircraft© the war zone

The future aircraft intended to be common to all branches of the United States Armed Forces will not materialize. The U.S. Navy has decided to develop its futuristic F/A-XX aircraft independently of the NGAD program. This design could bear the burden of aerial combat against Chinese aviation in the event of a conflict.

The NGAD program was supposed to identify a sixth-generation future aircraft for the U.S. Air Force—a machine intended to replace the [F-22 Raptor fighter jets](#) and, eventually, work alongside the F-35 aircraft currently being inducted into service. A component of the joint NGAD program for the entire armed forces was

the F/A-XX program, which aimed to build a future aircraft that meets naval requirements.

Due to budget issues and forecasts suggesting that a single [NGAD aircraft could cost several hundred million dollars](#), the program's future came into question. As a result, the U.S. Navy decided to develop the new carrier-based aircraft independently, advancing the **F/A-XX program**.

The U.S. Navy's decision was announced in an interview with Rear Admiral Michael Donnelly by "Aviation Week." The independent development of the new carrier-based aircraft aims to protect this crucial machine from potential problems, budget cuts, and delays.

American naval aviation

American naval aviation—alongside transport aircraft like the C-2A Greyhound or the early warning E-2D Advanced Hawkeye—currently consists of two types of combat aircraft. The first and most numerous is the Super Hornet. Its predecessor is the F/A-18 Hornet, an aircraft **developed alongside the F-16**, which lost the competition for the U.S. Air Force but was chosen by the U.S. Navy.

Over the years, many international users, including Finland, Spain, and Switzerland, have appreciated the F/A-18's advantages.

The modernized, updated, and enlarged version of the Hornet, the currently dominant **F/A-18E/F Super Hornet**, operates on the decks of American aircraft carriers. The original, older machines are still in service but remain only with the U.S. Marine Corps.

The second gradually implemented type of carrier-based aircraft is the F-35C, the "naval" variant of the F-35. Compared to the F-35A, the F-35C has enlarged, foldable wings and control surfaces, reinforced landing gear, and a typical carrier aircraft hook for landing with arresting gear.

This dual system of maintaining two main types of combat aircraft has ensured naval aviation's continuous **modernity and readiness**. The F/A-18E/F Super Hornet complemented the original F/A-18 when they were withdrawn, and the F-35C is becoming the complement to the F/A-18E/F.

Once the Super Hornets (and electronic warfare aircraft EA-18G Growlers) are retired, the F-35C will be supplemented by future aircraft developed under the F/A-XX program.

A new carrier-based aircraft for American aircraft carriers

The origins of this machine date back to 2008, but the Navy only presented the general requirements for the future naval combat aircraft in 2012. It aims to provide new capabilities in air combat, striking ground targets—including close air support—and electronic warfare.

It is worth emphasizing the new design's planned versatility. Specialized fighter aircraft like the **F-14 Tomcat** were withdrawn from service in 2006, and the new-generation specialized strike aircraft **A-12 Avenger II** never emerged.

The Navy has not publicly disclosed a detailed concept for the new aircraft. However, a popular vision is of a relatively simple machine that realizes its full capabilities not as a single airplane but as part of the **Naval Integrated Fire Control-Counter Air (NIFC-CA)** system.

F/A-XX – a cog in the NIFC-CA machine

According to this concept, future combat aircraft will not only rely on their radars but primarily **draw information from other sources** due to advanced communication, such as satellite reconnaissance, early warning aircraft, or any other sensors that can enhance battlefield awareness.

Their survivability is ensured not by very high speed and maneuverability but by stealth capabilities, electronic warfare systems, and long-range weapons carried on board.

Such machines are expected to be the backbone of American naval aviation in the event of a conflict with Beijing, confronting new-generation Chinese aircraft

like the Chengdu J-20 or new combat drones. However, the U.S. Navy has little time to develop, produce, and deploy the new aircraft type.

The timeline that assumes aircraft resulting from the F/A-XX program will begin entering service in the early 2030s is crucial for the Navy. Although the last Super Hornets will leave the production line in 2027, the lifespan—**estimated at 9,000 flight hours**—for older aircraft of this type will begin to expire. Introducing their successors into service will become not an option but a necessity.

Air Force defers NGAD decision to Trump administration

The Air Force has decided to let the incoming Trump administration make its own decision on the path forward for its [Next Generation Air Dominance fighter](#). This summer, the Air Force paused its effort to develop and build a [sixth-generation fighter amid concerns about its potential costs](#) and began rethinking what it will need for a future war.

The review sparked by that decision includes reconsidering [what the Air Force needs to maintain air superiority](#) in a war against a major adversary such as China and redesigning NGAD to lower its costs - [perhaps to lower than those of an F-35](#). The decision on how to proceed with NGAD was originally expected by the end of December.

On Thursday, however, the service announced outgoing Air Force Secretary Frank Kendall will not decide how to proceed with NGAD. Instead, the Department of the Air Force will continue its analysis and keep options open for the next administration.

The Air Force also said it is extending its current contracts with firms to mature NGAD's technology and reduce risk, to keep industry teams intact and allow systems and designs to further progress. The service declined to provide more details on those contracts, including their value, how long they will be extended and who they are to. Lockheed Martin and Boeing are believed to be the leading contenders to build NGAD, although Northrop Grumman may reconsider its

decision to bow out of the program depending on how the Air Force's strategy shifts.

The service is also asking industry to update its schedule and milestone proposals to account for these delays.

The Air Force's highly classified NGAD program aims to replace the fifth-generation F-22 Raptor fleet sometime in the 2030s. The service envisions the crewed NGAD fighter as the core of a "family of systems" that would also include autonomous drone wingmen known as collaborative combat aircraft. It would also have a cutting-edge adaptive engine that could switch to the most efficient configuration, as well as advanced sensors, weaponry and data connectivity technology.

The Air Force originally planned to award a contract for NGAD in 2024, but that effort was likewise put on hold.

But after rumors spread earlier this year that NGAD was in budgetary trouble, Kendall said [in an interview with Defense News](#) that the program needed a redesign to bring its costs under control.

In that June interview, Kendall said the original price projections for NGAD were running about three times the price of an F-35, which cost between \$82 million and \$109 million apiece depending on the model. At that price point, Kendall said, the Air Force would only be able to buy a small number of NGAD fighters.

"The family of systems concept of Next Generation Air Dominance is alive and well," Kendall said at the time. "I can tell you that we are looking at the NGAD platform design concept to see if it's the right concept or not. ... We're looking at whether we can do something that's less expensive and do some trade-offs there."

At the [Defense News Conference](#) in September, Vice Chief of Staff Gen. Jim Slife said the Air Force is also rethinking how it will achieve air superiority in a highly contested environment, and noted that may not be the same thing as figuring out how to build a sixth-generation fighter platform.

The Air Force also wanted the potential NGAD redesign to better incorporate recent technology advancements such as collaborative combat aircraft.

But it remains uncertain what President-elect Donald Trump's victory will mean for the military's approach to air superiority. Elon Musk and Vivek Ramaswamy, who Trump named to head a Department of Government Efficiency advisory panel, have each expressed skepticism over the value of crewed fighters in a future war.

Musk said [in a series of tweets](#) in November that "manned fighter jets are obsolete in the age of drones" and called those who build crewed fighters like the F-35 "idiots."

Ramaswamy also said at the Aspen Security Forum in Washington on Wednesday that the U.S. should be investing more in drones and hypersonic missiles than "new kinds of fighter jets or whatever, that aren't the highest" return on investment.

The Air Force told Defense News it has enough money to keep funding technology maturation and risk reduction for NGAD, and that the effort to build CCAs will continue uninterrupted.

Su-75 Checkmate: Russia's Joke of a Stealth Fighter?



Su-75© Provided by National Interest

Su-75 Update: The Su-75 "Checkmate" fighter is [reportedly](#) in the final stages of development, the United Aircraft Corporation (UAC) [confirmed](#). Russia is banking

on their new fighter attracting buyers on the export market, but so far, interest in the Checkmate has been scant.

Developed for Export

The Russians built the Su-75 as an airframe that could be exported. Anticipated buyers have included India, Iran, Argentina, the United Arab Emirates (UAE), and Saudi Arabia. But to date, countries have been [hesitant](#) to commit to a contract with the Kremlin for the new fighter.

Marketed as a cheap substitute for the F-35 Joint Strike Fighter, the Su-75 was a Russian attempt to cut into America's share of the international fighter export market. However the availability of the Su-75 alternative, first unveiled at the [MAKS 2021](#) Air Show, has not generated the anticipated interest in the export market.

However, the Su-75 was designed to be attractive to export buyers; with one engine, the light tactical fighter carries advanced avionics and weapons and has positioned itself against the competition as a low-cost yet capable option.

"Despite its high-profile unveiling...Russia's Su-75 Checkmate stealth fighter is facing headwinds in attracting international partners and competing in the global defense market," Army Recognition [reported](#). "Countries like the UAE and India have not eagerly partnered in the program, indicating limited success for Moscow's new military aircraft in the international arena."

The Kremlin's initial hope was that 300 Su-75s could be [exported](#) over fifteen years at about twenty per year. But that number no longer seems attainable. The inability to sell the Su-75 is indicative of a larger problem: the Russians are having trouble selling their wares to foreign clients.

Just recently, Russia slipped from its long-held position as the number two exporter of arms globally, falling to third behind France. Russia's slip to third may be a result of the pariah status Putin's regime has attained since illegally invading Ukraine.

What is the Su-75

Built as a low-cost alternative to the \$90-million-per-unit F-35, the Su-75 is meant to be a bargain fighter-generation fighter. With one Izdeliye thirty engine,

the Su-75 is [understood](#) to have a top speed of Mach 1.8 and a range of about 3,000 kilometers.

Like other fifth-generation fighters designed to maintain a low radar cross section (RCS), the Su-75 features an internal weapons bay, which is believed to hold upwards of 7,400 kilograms of ordnance.

The jet's most distinctive feature, visually, is the V-shaped "ruddervators," which serve as something of a compromise between horizontal and vertical stabilizers, instead combining the two structures into one, again, for the sake of keeping the RCS low.

Eventually, [someone](#) will buy the [Su-75](#). And you can expect the United States to keep tabs when that does happen, as a purchase of the Su-75 will not only dip into the American fighter's market share but will also signal an openness to dealing with Putin.

[Harrison Kass](#) is a defense and national security writer with over 1,000 total pieces on issues involving global affairs. An attorney, pilot, guitarist, and minor pro hockey player, Harrison joined the US Air Force as a Pilot Trainee but was medically discharged. Harrison holds a BA from Lake Forest College, a JD from the University of Oregon, and an MA from New York University. Harrison listens to Dokken.

'FLRAA Will Dramatically Increase The Reach Of Army Air Assault' U.S. Army Says



The U.S. Army believes the new FLRAA aircraft is going to be a game-changer for modern warfare: “Twice as Far, Twice as Fast”.

Two years ago, on Dec. 5, 2022, the U.S. Army awarded the Future Long Range Assault Aircraft contract to Bell and its [V-280 Valor tiltrotor](#) aircraft, marking the service's largest helicopter procurement decision in 40 years. The Army initiated the FLRAA program in 2019 as part of its Future Vertical Lift initiative to replace a portion of its assault and utility helicopter fleet and, in particular, to eventually replace roughly 2,000 [UH-60 Black Hawk utility helicopters](#). FLRAA, however, will not serve as a one-for-one replacement for the UH-60, but it's intended to take over its roles around 2030.

The next-generation tilt-rotor aircraft features greater speed, range, and survivability, making it a critical upgrade from the UH-60 Black Hawk.

As we explained in an [in-depth article](#) published when the announcement was done:

..the Army doctrine established to counter current and future threats required new capabilities, which are speed, range and transformational capability. Operating further away and maintaining some distance from threats have been demonstrated [in real world events](#) to be among the most important capabilities right now.

Tiltrotor technology is considered a leap ahead in this sense and will give the Army relevance and opportunity especially over the long distances in the Pacific region. This will also enable the Army to make some sweeping doctrinal and tactics, techniques and procedures (TTP) changes over the course of the next decades, opening to new possibilities that were not considered before.

Modernization is needed, in fact, in today's environment and multidomain operations to gain a competitive advantage.

Bell's officials also told us that work on the BA609 ([now Leonardo AW609](#)), along with the lessons learned from the XV-3, XV-15 and over 600k hours of operational experience from the V-22, played a significant role in the development of the V-280, contributing to the design and burning down a significant amount of risk.

Building on this experience, Bell pitched the V-280 as a third-generation tiltrotor, succeeding the [second-generation Bell-Boeing V-22](#). A notable difference in the design of the two types is the V-280's fixed engine nacelle, compared to the V-22's nacelles which tilt along with its rotors. The company said this design will reduce manufacturing costs and provide better performance, maintainability and sustainability.

The aircraft is not being designed around a specific theater, according to the company, but it's designed around reach, survivable range, speed and convergence of effects, allowing a force to get inside the decision cycle of an adversary in order to gain and maintain an overmatch over that adversary. That reach also gives the opportunity to put forces anywhere and anytime to deter adversaries.

Also, Bell says that Valor will be able to perform all the [mission sets of the Black Hawk](#) with the same footprint and the same infrastructure, [including sling loading](#) and urban operations. It is likely that, thanks also to the modular open systems approach, specialised variants will be developed as full-scale mockups have been displayed in various configurations, including as a pure assault platform, a weapons platform with roll-on/roll-off capability, and in a medevac configuration.

With its ability to fly farther and faster, the FLRAA will allow combat aviation brigades to operate on a much larger battlefield, pushing the boundaries of what's possible in contested environments. Maj. Gen. Clair Gill, head of the Army Aviation Center of Excellence, at Fort Novosel, Alabama, put it simply in a [recent press release](#): "The speed of technology is absolutely meteoric."

Addressing Modern Warfare Challenges

The Army's current air assault capabilities fall short in today's high-speed, long-range warfare scenarios. Maj. Gen. Brett Sylvia of the 101st Airborne Division explained the gap: "We can't perform large-scale, long-range air assaults at the speed and distance modern missions demand."

Recent exercises highlighted such limitations. In a notable example, the 101st moved a combat team 575 miles from Fort Campbell, Kentucky, to Fort Johnson, Louisiana. The operation required three nights, two mission support sites, six forward refueling points, and 1,000 personnel for logistics and security. According to Sylvia, with the FLRAA, that same mission could be shortened and done in a single night with half the support infrastructure.

The FLRAA is also playing a crucial role in improving how the U.S. Army will move critically injured soldiers: faster, over longer distances, with less need to refuel. Brig. Gen. Cain Baker, director for the Future Vertical Lift Cross Functional Team at Redstone Arsenal in Huntsville, Alabama, said that FLRAA will be able to carry out casualty evacuations faster, over longer range and more efficiently.

Moreover, advanced communication systems will allow medical teams at field hospitals to prepare for incoming patients in real-time, saving precious minutes when lives are on the line.

According to the U.S. Army, the FLRAA is catching the attention of Special Operations Commands and allies worldwide. Phillips noted that many allied nations are aligning their resources to join the program, with plans to purchase the aircraft once it becomes available for export in the 2030s.

Maj. Gen. Clair Gill sees FLRAA as a symbol of the Army's transformation. "This is a very transformational branch right now," the commanding general of the Army Aviation Center of Excellence said.

Russia's S-70 Okhotnik-B Stealth Drone: We Have Questions



Sukhoi S-70 Okhotnik-B© Provided by National Interest

S-70 Okhotnik-B, Explained: Two of the most prominent trends in aerospace development are one, stealth, and two, unmanned vehicles. Both trends have been combined in the ongoing development of Russia's new stealth drone, the [S-70 Okhotnik-B](#), a heavy unmanned combat aerial vehicle (UCAV).

Building the Future

As Elon Musk once famously predicted, the pilot's era is rapidly coming to a close; the future of aerial combat will be unmanned. The remote piloting of otherwise manned aircraft, like the F-16, as well as the development of both autonomous and remote-piloted aircraft, suggest that the pilot's era may indeed be concluding.

Of course, the era's conclusion will take decades still, the world's air forces still rely primarily on manned aircraft, with heavy investments made in brand-new manned aircraft like the F-35 and the F-15EX. However new programs are pushing the boundaries of unmanned capability. In time, no doubt, those unmanned capabilities will match manned capabilities, at which point the risk of strapping a pilot aboard an aircraft will no longer be worth the dangers and chance of human error imposed.

The Russians, for their part, have been [developing](#) the S-70 since 2011 or so. Rival firms, MiG and Sukhoi, have been collaborating to build the S-70, which is being billed as a sixth-generation unmanned aerial vehicle.

The S-70's development has been a slow go, with the first taxiing tests occurring in 2018, and the first flight tests, with an altitude of just a few meters above the runway, occurring in Spring 2019.

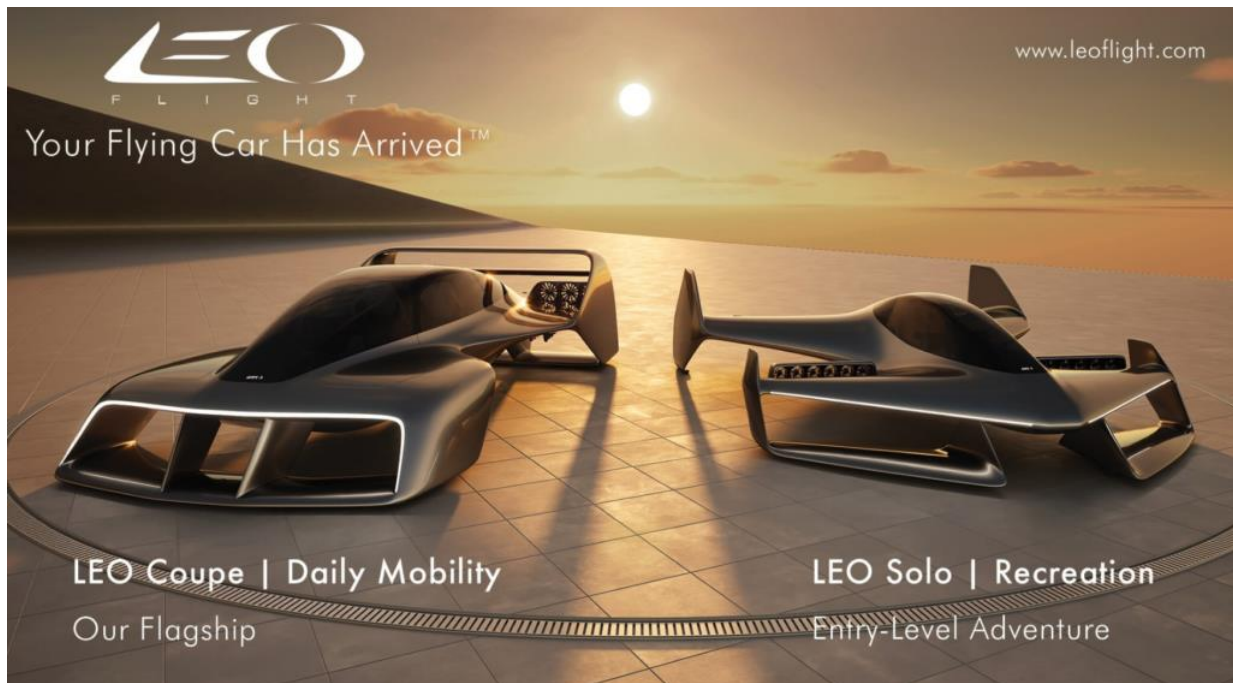
By the end of summer 2019, the S-70 was being taken on short flights, with altitudes of 600 meters or so. Serial production was expected to begin before the end of 2024, but with just four weeks remaining in the year, and no production underway, that projection seems unlikely. To date, just two S-70s have been built. In fact, one was [shot down](#) over the skies of Ukraine.

The Russians used an Su-57 to shoot down the S-70 after the drone lost contact with ground control and flew into Ukrainian territory, fearing that the Ukrainians would recover the S-70 and glean tech secrets from the new drone. The Russians even went as [far](#) as to target the crash site with a missile, to further [degrade](#) the wreckage and reduce the likelihood that the Ukrainians recovered anything useful. However, the Ukrainian police reportedly [recovered](#) portions of the downed drone.

The [S-70](#) features a flying wing design, featuring a sixty-five-foot-long wingspan. The drone has a maximum takeoff weight of 55,000 pounds and can carry up to 4400 pounds worth of guided and unguided munitions. The S-70 has a maximum speed of 620 miles per hour (Mach 0.82) and a range of 3,700 miles. For propulsion, the S-70 relies on one AI-41F-derived engine.

Given the heavy losses Russia is currently incurring in Ukraine, don't expect [stealth drone](#) development to be a top-tier priority; a full-production run for the S-70 may not be in Putin's near-term plans.

[Harrison Kass](#) is a defense and national security writer with over 1,000 total pieces on issues involving global affairs. An attorney, pilot, guitarist, and minor pro hockey player, Harrison joined the US Air Force as a Pilot Trainee but was medically discharged. [Harrison](#) holds a BA from Lake Forest College, a JD from the University of Oregon, and an MA from New York University. Harrison listens to Dokken.



eVTOL aircraft LEO Coupe and LEO Solo from LEO Flight showcased at CES 2025.

LEO Flight Corporation, the pioneer of electric jet-powered personal flying cars, has virtually debuted its LEO Solo single-seat recreational eVTOL vehicle at CES 2025 (Consumer Electronics Show) with support from the Indiana Economic Development Corporation (IEDC), spotlighting Indiana's commitment to innovation and leadership in the future of mobility.

Making its public debut during CES through a virtual reality showcase, the LEO Solo is a single-seat recreational eVTOL

designed for accessibility and adventure. Fully funded and slated for production in late 2025, the Solo offers a glimpse into the future of personal flight. Complying with FAA Part 103 ultralight regulations, it allows enthusiasts to experience flight without a pilot's license. Additional details, including pre-order opportunities, are expected to be announced as development progresses.

The Coupe, a luxury two-seat flying car, combines high-speed intercity travel with premium features. Vehicle certification is expected under the new FAA MOSAIC guidelines, which will require just 20 hours of flight time to obtain a pilot's license. With a target launch in 2027/2028, the Coupe represents the future of personal transportation.

LEO Flight's Founders Pete Bitar and Carlos Salaff hosted the virtual reality showcase, guiding attendees through the VR experience and sharing insights into the development of the LEO Solo and LEO Coupe.

Pete Bitar, Co-Founder of LEO Flight, said, *"LEO Flight is honored to showcase its vision for the future of flight with support from the Indiana Economic Development Corporation (IEDC). Our alignment with IEDC's mission to drive economic growth and innovation in Indiana has been instrumental in our journey to revolutionize personal mobility."*