

AVIATION VOL 3



X'ian H-20 Vs B-21 Raider: How The Rival Stealth Bombers Stack Up

The Chinese X'ian H-20 and the Northrop Grumman B-21 Raider represent the latest advancements in Stealth Bomber technology, each promising cutting-edge capabilities to enhance their respective military capabilities. With long-range flight, advanced stealth, and formidable payload capacities, these aircraft are designed to meet strategic needs in a high-threat environment. The following comparison highlights key differences in design, function, and capability.

Design and Stealth Capabilities

The X'ian [H-20](#) and [B-21 Raider](#) share an emphasis on stealth to penetrate enemy air defenses undetected. Both are likely to incorporate radar-absorbent materials and features to minimize visibility across multiple spectrums, although official details remain classified. The [B-21 Raider's](#) open-systems architecture and design flexibility support future upgrades in stealth and avionics, ensuring sustained adaptability against evolving threats.

Photo: China Social Network

China's H-20, also designed with stealth as a primary characteristic, reflects China's goal of long-range power projection, potentially reaching targets in the US Pacific territories. As reported by the [National Interest](#), "The H-20's estimated range capability, reportedly able to strike U.S. bases as far as Hawaii, underscores China's strategic ambitions in the Asia-Pacific."

Payload and Armament

Both bombers are intended to carry a mix of conventional and nuclear payloads, with designs optimized for versatility in weapons deployment. The B-21's payload options include standoff and direct-attack munitions, supported by its integration capabilities, allowing the aircraft to deploy advanced weapons as they become available.

Photo: Weibo

While less defined, the H-20's payload is expected to mirror this versatility, likely incorporating similar payload flexibility for regional and intercontinental missions. According to the Foreign Military Studies Office (FMSO, fmso.tradoc.army.mil), the H-20's heavy-payload capability provides China with an aircraft capable of delivering large volumes of ordnance or a strategic nuclear load over long distances.

Operational Range

The range capabilities of these bombers distinguish their intended operational roles. The B-21 Raider is projected to offer a substantial operational range, sufficient to target strategic locations globally from US bases, and the flexibility to be refueled mid-air to extend its reach further.

The H-20's range, which is believed to approach that of the B-21, is critical to China's regional and global power projection, enabling missions that could potentially reach U.S. Pacific installations. A senior U.S. defense official [noted](#), "The B-21's strategic reach and the capability to operate in contested environments secure it as the backbone of the future bomber force."

Technological Integration

The B-21's design emphasizes integration with future combat systems, an essential feature for maintaining relevance as threats evolve. Its systems will facilitate communication and interoperability with US and allied forces, enhancing collaborative operations. The H-20's integration technology is likely focused on achieving regional dominance, especially in the East and South China Seas, though it may not match the B-21's level of integration with allied forces.

Production and Cost

Production costs for the B-21 Raider were minimized by leveraging existing technology and modular production methods, keeping the average unit procurement cost (APUC) around \$692 million as of 2022. China's H-20, developed by Xi'an Aircraft Industrial Corporation, likely also seeks cost-efficiency while meeting high-stakes regional demands, though its unit cost remains undisclosed.

Both projects reflect substantial investment in national defense, though the B-21's open-systems design aims to further reduce lifecycle costs by enabling modular upgrades and reducing the need for total overhauls.

East vs. West Stealth Bomber Comparison

- **B-21** Raider: Nuclear-capable stealth bomber, operational range estimated around 6,000 miles (9,656 km), payload capacity not fully disclosed, unit procurement cost: \$692 million as of 2022.
- H-20 Bomber: Estimated range of up to 5,300 miles (8,530 km), payload capacity speculated at approximately 20 tons (18,143 kg), cost undisclosed.

The B-21 Raider and the H-20 reflect their nations' distinct strategic priorities. The B-21's design prioritizes adaptability and integration, focusing on global reach and alliance interoperability, ensuring relevance in complex operational theaters. The H-20 aligns with China's strategic focus on regional dominance, particularly in the Asia-Pacific. Both bombers mark substantial advances in stealth technology and are tailored to confront high-threat environments, ensuring each nation remains competitive in future aerial combat scenarios.

The B-21 Raider represents a stunning leap in stealth air power but the question remains as to the true cost of such technology.

What Does The Inside Of A Commercial JetZero Look Like?



Commercial JetZero flying in the skies against the clouds© JetZero

The inside of a JetZero jet doesn't look like a traditional airliner — because it isn't one. Instead of a long, narrow tube with two aisles, JetZero's blended wing design creates a wide, open cabin. The Z4 cabin offers up to 2,400 square feet of usable space (similar to a Boeing 787-8, one of [the best jets Boeing has ever made](#)) but distributed differently. The fuselage is essentially one big lifting surface, so JetZero can embed the passenger cabin inside a wing-like structure. Seating isn't jammed into a narrow cylinder; it's placed in separate zones or "bays" divided by structural columns.

Each bay can be customized. Airlines could place lie-flat business seats up front, 2-3-2 seating in the middle, and economy further back in a 2-5-2 layout with four

aisles. Even premium suites or lounges can be tucked between cabin sections. There's also dedicated baggage space per passenger — something rare even on widebody jets — which means you can [check in your laptop if you want](#).

Despite the radically different structure, JetZero says the aircraft can still use standard jet bridges and gates. No redesign needed at the airport. It fits within the same footprint as existing twin-aisle jets but uses the space inside far more efficiently. That's where the layout breaks away from convention and starts to get interesting.

No Windows? No Problem



Inside of a commercial JetZero with seats and a screen© JetZero

The rear section of the cabin has no traditional windows, and JetZero is fine with that. The forward cabin includes some side windows between the front doors, but most of the light comes from above. Overhead skylights and front-side openings flood the interior with natural light during the day. At night or in low light, it's all

about simulated views. JetZero is looking to incorporate large, high-resolution displays into the sidewalls.

These can project everything from panoramic skies to digital "windows" showing what's outside in real time. The result is a cabin that can change depending on airline brand, time of day, or passenger preferences.

Also worth noting: The structural layout creates gaps in the walls where strength isn't needed. These empty cells allow light to pass through and give the interior a more open feel, even without full-size windows. It's an approach borrowed from regenerative building design.

Flex Zones, Central Galleys, And A Bar



Inside cabin of a JetZero© JetZero

JetZero built a full-scale mockup of its Z4 interior in Long Beach, and it makes one thing clear: This isn't just theoretical. The mockup includes all key features—four aisles, a central galley, and varied seating concepts.

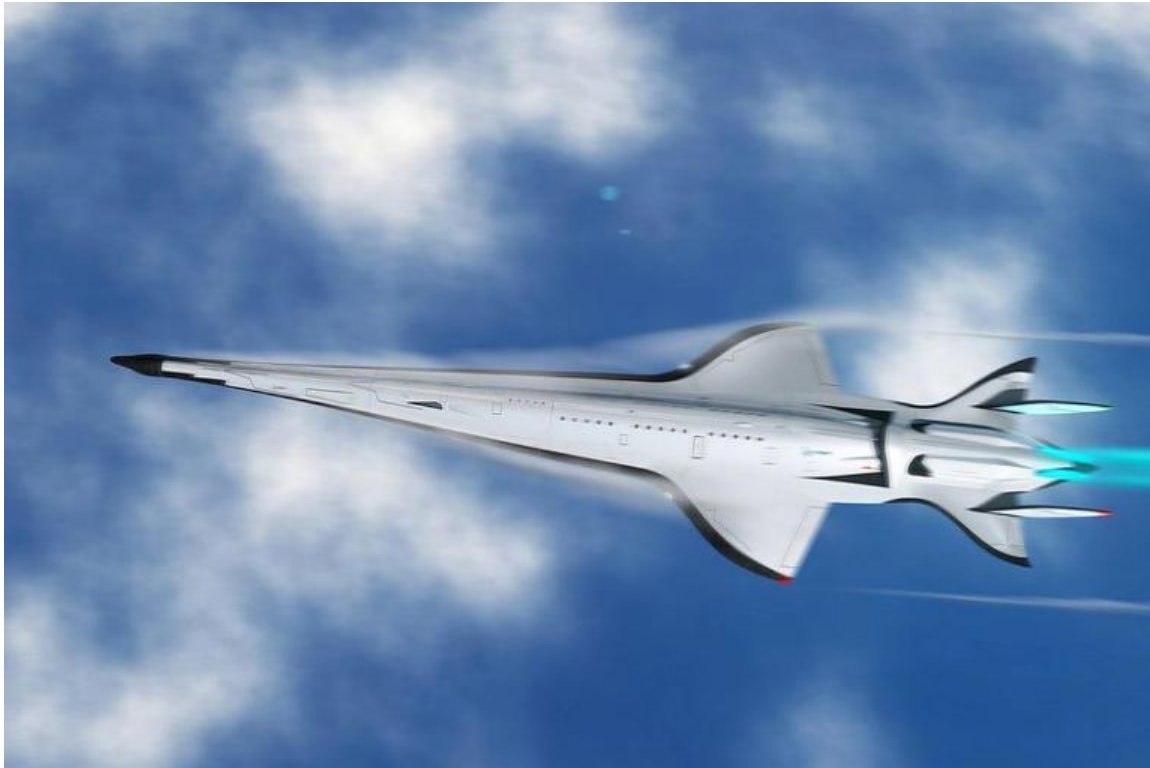
One major difference from tube-and-wing aircraft is the central galley. Instead of putting food prep at the front and rear, JetZero places a single galley in the middle of the plane, serving all sections. It's more efficient and frees up room at the nose and tail for seating, crew rest, or even cargo. The galley sits between the

two forward seating bays (usually the business class zones) and can be configured to meet different airline needs.

Then there's the bar. Yes, a full-size lounge bar was installed in the demo build — not because every airline will want it, but to show that the space allows for it. More importantly, the four-aisle layout enables fast movement around the cabin. No more waiting behind meal carts just to reach the lavatory.

The mockup also showcases potential crew rest areas and a boom operator station for military variants, tucked behind curtains or into wall recesses. Every section is modular. JetZero's goal is to offer airlines more control, not to dictate what the cabin has to look like. It's definitely up there among the [strangest aircraft designs to ever take to the sky](#) — but it's got a solid functionality to back it up.

'New Concorde' will cut US to UK flight time to 45 minutes and travel seven times faster than speed of sound



Spanish designer Oscar Viñals's image of the A-HyM Hypersonic Air Master© SWNS

A revolutionary hypersonic airliner, the A-HyM Hypersonic Air Master, [could slash London-New York flight times](#) to a mere 45 minutes.

This groundbreaking aircraft is set to revolutionize air travel by flying at Mach 7.3-over 5,600 mph. Designed to carry 170 passengers, it could reduce the transatlantic journey from the usual seven hours, making transatlantic travel quicker than ever before.

In comparison, Concorde typically flew from London to New York in just under three and a half hours, compared to about eight hours on a subsonic flight. It comes after [the TSA revealed a new list of 16 items that are banned from passengers' checked bags](#).

Spanish designer Oscar Viñals says the A-HyM would cruise at an altitude of 30,000 meters, far above conventional jets, using advanced heat-resistant materials like titanium and carbon fiber to withstand temperatures up to 1,832°F.

Its innovative Sonic Boom Mitigation System aims to reduce the disruptive noise of breaking the sound barrier, potentially allowing supersonic and even [hypersonic flights](#) over land without disturbing communities below, reports [the Mirror](#).

Powered by a next-generation hydrogen-fueled combined-cycle engine, the [aircraft would blend turbojet, ramjet, and oblique detonation technologies](#) for both speed and eco-friendliness.

Inside, passengers would enjoy spacious, comfortable cabins equipped with virtual panoramic windows and advanced entertainment systems designed to handle the unique conditions of hypersonic flight.



Spanish designer Oscar Viñals's image of the A-HyM Hypersonic Air Master© Reach Publishing Services Limited

The A-HyM, a concept aircraft, is showcasing how advancements in materials science, propulsion systems, and aerodynamics are making ultra-fast and sustainable global travel more feasible than ever.

Oscar Viñals, the visionary behind the project, said: "This aircraft concept would allow its users not only to experience a unique flight at dizzying speeds in excellent conditions, but it would also allow them to "master" time, because a trip, for example, from [London](#) to Los Angeles would only take an hour and a half, from boarding at Heathrow international airport to disembarking at [LAX](#) (Los Angeles International Airport)."

But the team behind the A-HyM isn't alone in chasing the dream of [commercial supersonic flight](#). In January, the Boom supersonic jet - often referred to as the 'new Concorde' - officially broke the sound barrier.



Spanish designer Oscar Viñals's image of the A-HyM Hypersonic Air Master © Reach Publishing Services Limited

Boom, a Colorado-based company, launched its XB-1 test plane from California's Mojave Air and Space Port for a test flight in January. The plane reached a speed of Mach 1.1, or 844 miles per hour, while flying at about 35,000 feet.

A [plane](#) is considered 'supersonic' once it surpasses Mach 1. The Boom XB-1 is the first civil supersonic jet made in the US to break the sound barrier.

The challenge of breaking through the sound barrier, and the loud bang that occurs when planes do, is part of why super-fast air travel has been difficult to achieve from a business perspective.

As stunning and iconic as the Concorde's curved delta wing shape was, it had a fundamental flaw that led to its eventual retirement. Breaking the sound barrier creates a massive sonic boom that can wreak havoc on the ground below.

During a 1965 test over Oklahoma City by the US Air Force, hundreds of reports of shattered windows were filed.

This potential for disruption meant that the [Concorde could only fly certain routes at supersonic speeds](#), prohibiting high-speed flights over land. This limitation severely impacted the aircraft's business case in the US, as it couldn't effectively connect major cities like Los Angeles and New York.

[Climate scientists](#) also raised concerns about the Concorde's impact on the ozone layer, specifically the potentially harmful effects of its emissions while flying at 60,000 feet - a necessary altitude for the plane to reach air thin enough.

The relatively small passenger capacity combined with the large amount of fuel needed for such high-speed travel meant that fluctuations in oil prices hit the airline hard. At times, customers were shelling out nearly \$12,000 for a single trip back in 2003.

Operators Air France and [British Airways](#) even had to have backup planes made, further adding to the mounting costs.

Reasons The USAF Thinks The B-21 Raider Might Fit An NGAD Fighter Role

Published Oct 29, 2024



Photo: Boeing, USAF, Simple Flying

[The War Zone](#) recently reported that **United States Air Force** Chief of Staff Gen. David Allivin as saying the NGAD **6th generation fighter jet** is undergoing a deep review. Allivin was asked at an event, "*As the NGAD review goes forward, like, is it possible that what that ends up with could be the B-21 taking a larger role?*" Allivin replied, "*We have not taken that off the table.*" [Concerns about the aircraft's high costs \(expected to be \\$300 million or more each\)](#) triggered the review in the NGAD. Emerging technologies (like advanced unmanned platforms) are also likely to be considered. Here are some reasons the B-21 Raider could partially fit an NGAD role.

B-21 Raider appears suited for air-to-air combat

The Raider is 'multi-functional' platform

Number built:	3 (prototype)
First flew:	2023
Manufacturer:	Northrop Grumman

Simple Flying recently wrote that the B-21 Raider could (theoretically) be used in an air superiority role . After all, the **Northrop Grumman B-21 Raider** resembles more of a massive stealthy flying supercomputer with the world's most advanced suite of sensors and electronics than a traditional bomber.



Photo: USAF

The War Zone notes, "*the B-21's size, long-range, high-altitude ceiling, broadband low-observability (stealthiness), and other capabilities could actually make it well suited to supporting certain forms of air-to-air combat.*"

A system of systems

The Raider could be around \$400 more expensive than NGAD

Collaborative Combat Aircraft:	General Atomics XQ-67, Anduril Fury
B-21 Raider cost:	Approx. \$700 million per aircraft:
NGAD cost:	Approx. \$300 million per aircraft

NGAD is destined to be a penetrating system of systems operating as a command platform with AI-enabled drones that could do the actual fighting. Similarly, the B-21 Raider is a penetrating command platform that could also function (at least in part) as a system of systems commanding loyal wingman drones (called Collaborative Combat Aircraft by the Air Force).

As time moves on, warplanes are taking on greater roles. Fighter jets are now almost exclusively multi-role fighters and not dedicated air superiority fighters. It seems a natural step that this will extend into the next generation of bombers. Moreover, the next generation of fighter jets appears set to do less of the actual fighting themselves (a task partially outsourced to CCAs). Sixth-generation fighter jets seem to be progressing while constantly facing the risk of cancelation.



B-21 Raider is a six-generation aircraft

The world's first six-generation warplane.

4.5th gen fighters: F/A-18 Super Hornet, F-16 Block 70, F-15 Strike Eagle II

5th gen fighters: F-35, F-22, (F-117 first stealth plane)

6th gen fighters: NGAD, F/A-XX, (B-21 Raider claimed)

The terms 4th, 5th, 6th, etc. generation aircraft are used exclusively to refer to fighter jets. The B-52, B-1 Lancer, and B-2 Spirit are typically not referred to in these terms as they are not fighter jets - they are something else entirely. However, **Northrop Grumman** has taken to calling its B-21 Raider the world's first sixth-generation aircraft. While this could be just advertising, it could also be a clue into its potential as a fighter - or taking some of the role of the NGAD.



Photo: U.S. Air Force

NGAD is intended to function as an airborne nerve center for CCA and other platforms and to penetrate and fight in the most heavily contested airspace while coming out on top. This is something somewhat similar the Raider has been designed for.

Air Force hinted the B-21 has air-to-air capabilities

AIM-260 JATM has a range of at least 120 miles

Air superiority fighters:	F-22 Raptor, F-15 family
Multi-role fighters:	F-16, F/A-18, F-35
In service:	Expected mid-late 2020s

In 2019, then-Air Force Maj. Gen. Scott Pleus told [Air Force Magazine](#) (now Air & Space Forces Magazine), “*If we were to characterize it [NGAD] as a fighter, we would be... thinking too narrowly about what kind of airplane we need in a highly contested environment*” adding “*A B-21 that also has air-to-air capabilities*” and the ability “*to work with the family of systems to defend itself, utilizing stealth—maybe that’s where the sixth-generation airplane comes from.*”



Photo: Air Force Material Command

While it is not exactly clear if Pleus was saying the B-21 could or would be used in an air-to-air role, his comments can be read that way. As the Secretary of Defense said in December 2022, “*the B-21 is multi-functional.*” In other words, it may be best not to think in terms of bombers vs. fighters—perhaps it's both - perhaps a better designation could be the B/F-21 Raider.

5A versatile platform

Only 100 B-21 Raiders are currently planned



F-22 Raptors: 187 built (inc. at least 32 training aircraft)

NGADs: Approx. 200 planned

F-35s: Over 1,700 planned

The Raider is shaping up to be a very versatile platform. While large, it will have world-beating stealth and the potential to carry outsized very long-range air-to-air missiles (or a larger number of smaller air-to-air missiles). It could be fitted with equipment to conduct SEAD/DEAD missions, launch drones, and have other capabilities.

Photo: Northrop Grumman

However, the expected low production numbers of the B-21—around 100—are putting some cold water on the idea of its extensive use in NGAD roles. 100 is just too small a number (it is also planning to purchase around 200 NGAD manned fighters). The Air Force is known to be looking for a cheaper manned, stealthy platform ([cheaper than the F-35](#)) to act as a control center for the drones - maybe the Raider is too expensive and overkill to function as an NGAD fighter on any large scale.

F-19 Legacy Explored



In military aviation-matter of fact, and quite arguably the most two highly symbolic aircraft types that make an ideal combination is the F-19 Stealth Fighter.



Celebrating the F-4E Phantom II



China Spearheads a New Hypersonic Engine



China Spearheads a New Hypersonic Engine

Chinese scientists have once again innovated a new technology—and not just any technology, but an [extraordinary new engine](#) that could improve rotating detonation engines. It could have profound implications for the global economy and our national security.

Specifically, this invention could have serious impacts on China’s quest to become the dominant hypersonic weapons power in the world—not just in terms of military hypersonic capabilities, but even possibly creating hypersonic aircraft for civilian uses.

What is It?

It’s called a “Ram Rotor Detonation Engine” (RRDE). This hybrid engine fuses elements of both ramjet and pulse detonation engines (PDEs). Conventional combustion engines use flame propagation for burning fuel. The Ram Rotor

Detonation Engine, however, [utilizes](#) detonation to create a supersonic combustion wave that will result in a more efficient engine and greater thrust.

The proposed engine operates on a continuous cycle that includes four main phases. The first is air intake wherein air enters the engine at extremely high speeds (like a ramjet), compressing that air (the ram effect of "ramjet").

Next is fuel injection and mixing. Fuel is injected into the compressed air, creating combustion.

All this is set up for the actual detonation wave. This is where the [RRDE](#) significantly differs from PDEs, because RRDEs use a rotating detonation chamber. RRDEs have multiple detonation tubes arrayed in a radial pattern around a central hub. As the detonation wave travels around the roto, it continuously ignites new fuel-air mixtures.

Finally, there's the exhaust. The high-pressure, high-velocity gases exit through a nozzle, creating thrust for the vehicle employing this unique and innovative engine.

The technology is not without drawbacks and the Chinese are not the only group working on similar technology. Multiple academic institutions, such as research labs affiliated with NASA, an assortment of private aerospace firms, and researchers at the [University of Central Florida](#), as well as the [Air Force Research Laboratory \(AFRL\)](#), are all dedicating resources and manpower to being the first to create an RRDE engine.

The AFRL is a core linkage between the civilian and military realms and their interest helps explain why China is so interested in the technology.

The Geopolitical Implications

In regard to the military applications of the RRDE system, if the Chinese can make it work before anyone else can, it will allow for high-speed, [high-maneuverability fighter jets](#) where thrust-to-weight ratio and speed are crucial.

This technology could also be useful for spacecraft as a single-stage-to-orbit or upper stage engine; this technology's efficiency at high speeds could reduce the fuel mass fraction (and cut down on the onerous operational costs).

An RRDE would enable both military and commercial hypersonic flight. This tech could even be applied to missiles, thereby enhancing the speed and range of those missiles.

The RRDE is still experimental. But it is a quantum leap forward in the development of robust and durable hypersonic systems, both in the civilian and military realms. Americans should be concerned that the Chinese are out-innovating them in yet another aspect of critical hypersonic technology, especially since China, like Russia, is [already so far ahead](#) of the United States in terms of practical hypersonic weapons applications.

Boeing Sonic Cruiser

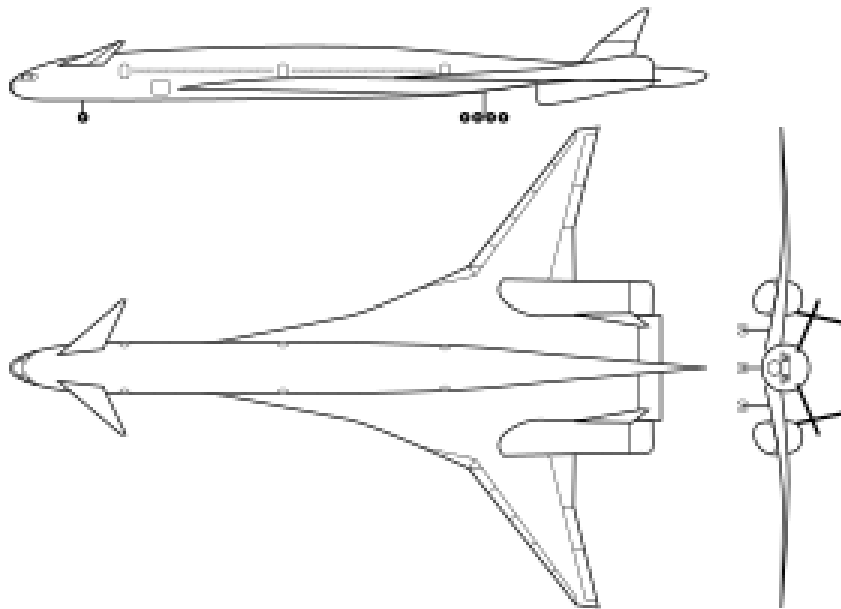
The **Boeing Sonic Cruiser** was a concept [jet airliner](#) with a [delta wing](#)–[canard](#) configuration. It was distinguished from conventional airliners by its delta wing and high-[subsonic/transonic](#) cruising speed of up to [Mach 0.98](#). [Boeing](#) first proposed it in 2001, but [airlines](#) generally preferred lower operating costs over higher speed. Boeing ended the Sonic Cruiser project in December 2002 and shifted to the slower (Mach 0.85) but more fuel-efficient 7E7 (later named [787 Dreamliner](#)) airliner.

Design and development

As well as wanting more direct flights, passengers have demonstrated a preference for flights that take less time and aeroplane configurations that enhance comfort. It's just common sense: people want to go where they want to go, when they want to go, how they want to go. Boeing's answer to the demand for faster flights, more direct flights and increased comfort is the Sonic Cruiser.

— Peter Rumsey, Director of New Airplane Product Development, *Ingenia*, February 2002^[2]

The Sonic Cruiser was born from one of numerous outline research and development projects that began in the 1990s at Boeing with the goal to look at potential designs for



a possible new near-sonic or supersonic airliner.^{[3][4][5]} The Sonic Cruiser was publicly unveiled on March 29, 2001,^[6] shortly after the launch of the [A380](#) by rival [Airbus](#). Boeing had recently withdrawn its proposed [747X](#) derivative from competition with the A380 when not enough airline interest was forthcoming,^[7] and instead proposed the Sonic Cruiser as a completely different approach.^[5] Instead of the A380's massive capacity, requiring a [hub and spoke](#) model of operation, the Sonic Cruiser was designed for rapid [point-to-point](#) connections for 200 to 250 passengers.^{[2][6]} Critics stated that Boeing had timed its announcement in an attempt to distract from the launch of the A380.^[7]

Boeing's 2001 patent^[9] detailed the breadth of delta wing-canard concepts studied, which included a supersonic variant with four engines capable of cruising at Mach 1.5 to 3.0,^[10] various tail, engine location, and inlet and outlet configurations,^[11] smaller supersonic and subsonic business jets,^[12] and what Boeing called a "modular" system, where the cruise speed could be changed from supersonic to near-sonic by an interchangeable nose;^[13] the "Sonic Cruiser" was a near-sonic variant.^[14] The origin has been traced back to 1995, with the formation of an internal Airplane Creation Process Strategy team, which had designed a plane code-named Project Glacier that strongly resembled the initial Sonic Cruiser drawings by fall 2000.^[4] In early 2001, Boeing CEO [Alan Mulally](#) began privately publicizing the concept to potential customers, touting its improved speed at an efficiency similar to existing designs.^[4]

[Don Carty](#) ([American Airlines](#)) and Sir [Richard Branson](#) ([Virgin Atlantic](#)) were openly enthusiastic for the Sonic Cruiser, and Branson expected to make a tentative order of three to six aircraft in May 2001.^[7] The March 29, 2001 announcement was followed by a larger media event at the [Paris Air Show](#) on June 19, where futurist [John Naisbitt](#) and Mulally praised the concept, unveiled as a 1/40th-scale model.^{[15][16]} [Popular Science](#) named the Sonic Cruiser to its list of the Best of What's New in 2001.^[17]

Palmer Luckey's defense tech company will make next-gen military aircraft with Archer



Palmer Luckey's defense tech company will make next-gen military aircraft with Archer© Image: Archer

Electric aviation startup [Archer Aviation](#) signed an exclusive deal with Palmer Luckey's defense contractor, Anduril Industries, to jointly develop next-generation aircraft for the military. Archer also announced a new funding round of \$450 million to help propel its defense ambitions.

The first product will be a hybrid propulsion vertical takeoff and landing (VTOL) aircraft that will serve as the basis for the companies' bid for a contract with the US Department of Defense. Archer is also formalizing its efforts to be an aircraft supplier to the military through the creation of a new internal division called Archer Defense.

While Archer has been racing to finalize the government certification process that it will need to get the necessary government approvals for its electric vertical takeoff and landing, or eVTOL, aircraft, it's also getting more deeply involved with the military-industrial complex. The San Jose, California-based company also recently delivered one of its Midnight eVTOL aircraft to the US Air Force as part of its evaluation program. Other advanced aviation companies have made similar moves.

The first product will be a hybrid propulsion vertical takeoff and landing aircraft Archer also announced it will be the recipient of a fresh capital round, with \$430 million coming from preexisting investors such as Stellantis and United Airlines as well as new funders like Wellington Management and Abu Dhabi investment holding company 2PointZero, a subsidiary of the United Arab Emirates' largest listed entity, IHC. Archer says it has raised a total of \$2 billion to date.

Archer [came out of stealth in spring 2020](#) after having poached key talent from Wisk (formerly Kitty Hawk) and [Airbus' Vahana](#) project. (Wisk later sued for alleged trade secret theft, which was finally [settled last year](#).) The company has a [\\$1 billion order from United Airlines](#) for its aircraft and a deal to mass-produce its eVTOL craft [with global automaker Stellantis](#).

Alongside Archer, other eVTOL companies hope to eventually win full Federal Aviation Administration approval. That got a boost recently when [the agency published](#) highly anticipated [final regulations](#) for eVTOL vehicles that it says will chart the path for the "air travel of the future." [Archer praised](#) the FAA for

“providing clear direction on what is required for the safe operation of eVTOL aircraft in the U.S.”

Air taxis, sometimes misidentified by the mainstream media as “flying cars,” are essentially helicopters without the noisy, polluting gas motors (though they certainly have their own unique noise profile). In addition to Archer, companies like [Joby Aviation](#), [Volocopter](#), and Beta Technologies have claimed they are on the cusp of launching services that will eventually scale up nationwide. But others have floundered; German company Lilium recently said that two of its subsidiaries [were insolvent and could cease operations](#).

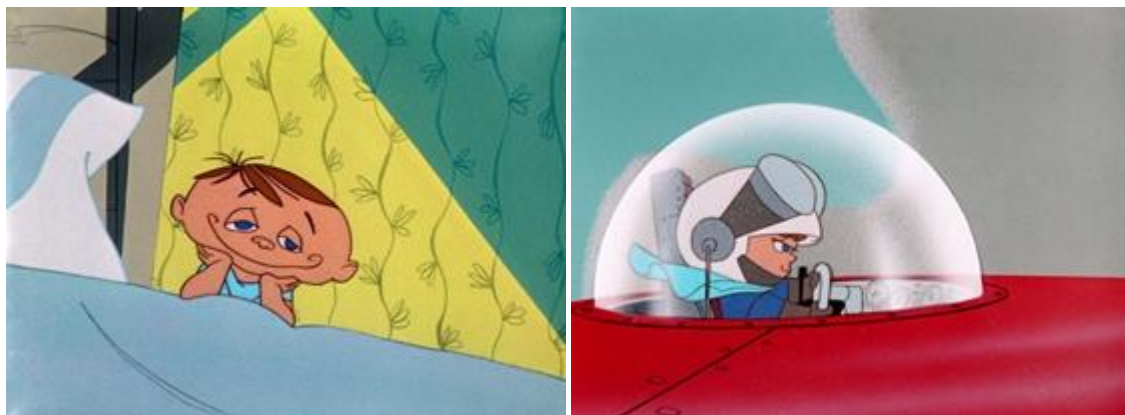
Meanwhile, Anduril is a military technology company, founded by Oculus creator Luckey, that makes surveillance and reconnaissance tech [as well as military drones](#). The company recently [teamed up with OpenAI](#) to integrate the ChatGPT maker’s software into Anduril’s counter-drone systems.

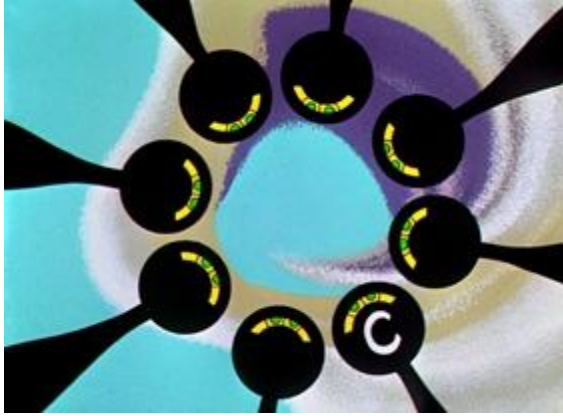
Air Force Nightmare: Is the NGAD Fighter Dead?



Boyhood Daze 1957 by Chuck Jones

THE FIRST APPEARANCE OF NGAD FIGHTER DESIGN







Young Ralph Phillips is scolded for breaking a window and sent to his room, where he lets his imagination run riot and fantasizes that he is a space ace pilot who single-handedly thwarts a Martian invasion. —

Quotes

Headquarters: Turn back! You are being pursued by a multitude of unfriendly Martians who all got A's in arithmetic!

Trivia

According to animation historian Don Markstein, Ralph Philips was Chuck Jones' version of the literary character Walter Mitty. Both are meek, put-upon characters who seek to escape reality through daydreaming about being heroes or villains. The main difference was that Walter is an adult trapped in an unhappy marriage, while Ralph is a little boy with mundane problems.

The United States Air Force *really wants* its [Next-Generation Air Dominance \(NGAD\)](#) sixth-generation warplane program. It's just too bad that its cost will likely outweigh whatever benefits that the Pentagon thinks the project will give it. Finally, the Air Force is coming to grips with the fact that its reach exceeds its grasp. At a recent congressional hearing, Biden administration Secretary of the Air Force Frank Kendall [officially](#) decided to kick the decision on whether to go forward with the NGAD program to the Trump administration.

It's a smart move. Not only is the Biden administration in its lame-duck session, but the NGAD program is prohibitively expensive and will require a long-term commitment to make the project work (if it ever can work as advertised, given the complexity of the systems involved and America's already ailing defense industrial base).

Now, the incoming Trump administration, which is still [waiting to hear](#) if its Secretary of Defense designate, Pete Hegseth, will be given Senate confirmation, must avoid the siren song that the permanent Pentagon bureaucracy will sing to [lure](#) Trump administration officials into supporting this wasteful project.

And it is wasteful.

Some Interesting Points

The specs for the NGAD program sound like something from Star Trek. It'll be artificial intelligence-driven, with a massive cloud computing capability linking the manned sixth-generation warplane (which costs a [whopping](#) \$300 million per plane, three times higher than the F-35 Lightning II fifth-generation warplane). The plane's pilot will be more machine than man, with massive technological augmentations to allow for greater situational awareness, over-the-horizon warfighting capabilities, and a sci-fi-like avionics package.

The "loyal wingman" component is particularly impressive.

Basically, for every single manned sixth-generation warplane in the [NGAD program](#), there will be swarms of either semi or fully autonomous drones operating alongside it. These drone swarms will, as the name suggests, provide vital air cover for the manned plane while in combat, but will also serve as long-range reconnaissance scouts and even force multipliers for the planes themselves

How will the Air Force build not just the planes but the underlying systems in a timely fashion? The F-35, after all, [has gone significantly over time and budget](#) from what the Air Force had originally planned for. Sure, the F-35 is highly technological. But it's not a starfighter. The Air Force is basically building a fleet of X-Wings, based on the description of the NGAD as a ["system of systems."](#)

But why can't the Pentagon just take some of the underlying systems—notably the "loyal wingman"—and apply them to existing airframes? Not just the F-35, but the superior [F-22A Raptor](#)? Heck, the Air Force has been practicing dropping drone swarms into combat zones during simulations in the desert, [turning](#) old F-16s into drones themselves! Is it really that difficult to simply attach some of the capabilities intended for the NGAD onto existing platforms?

Certainly, the drone aspect of the NGAD is much cheaper than the manned system that the Air Force is dead set on. Even some of the AI capabilities and cloud computing intended for the sixth-generation warplane can likely be tacked onto existing systems like the aforementioned F-22—all at a reduced cost than what taxpayers would be on the hook for paying with the NGAD.

An Unaffordable Program Will Have to Wait for the Next Administration

The Air Force cannot even guarantee it will be able to mass-produce the NGAD systems in a useful timeline. Even now, the [U.S. defense industrial base](#) is barely able to keep up with demand. As was noted earlier, the F-35 program ran massively over budget and time, in large part because the defense industrial base couldn't keep up.

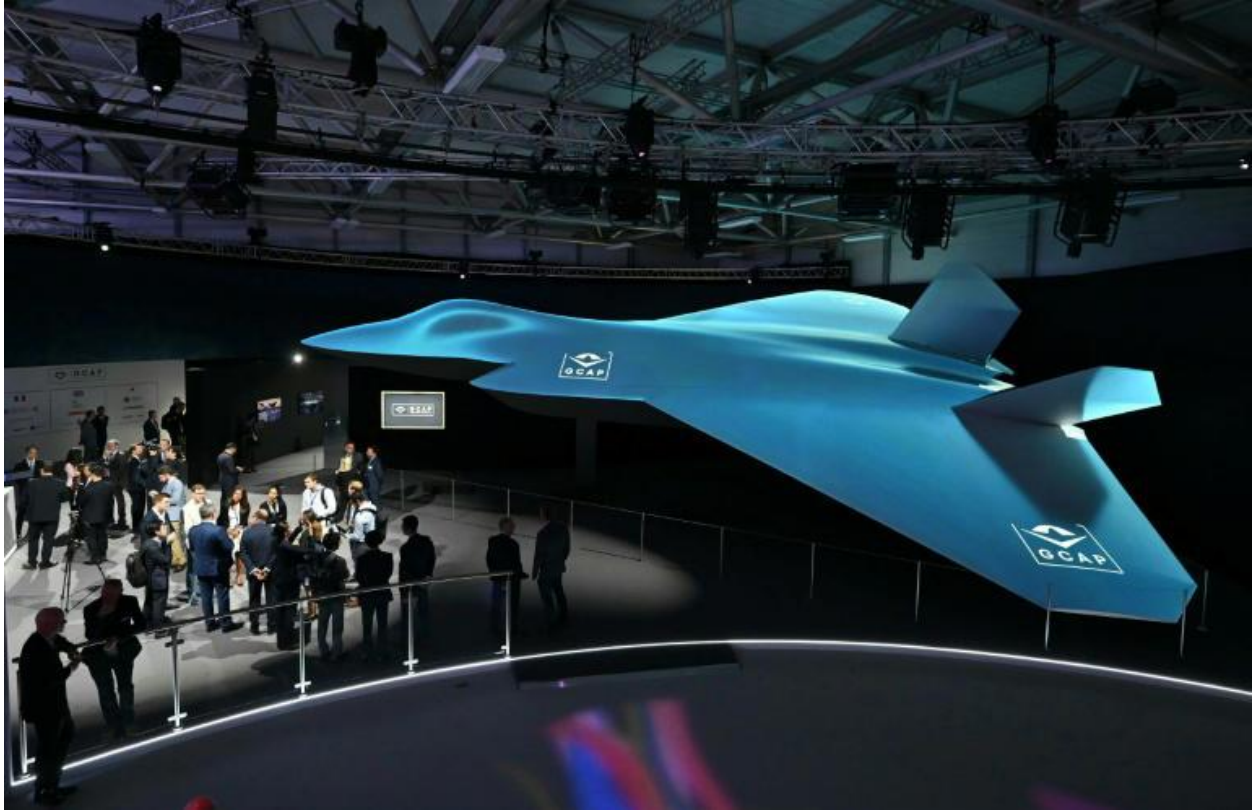
Meanwhile, the F-22 Raptor, America's top warplane, had its production line prematurely canceled in 2009 because of short-sighted political and economic reasons. There's no way that the Pentagon can ensure that the even more expensive and complex NGAD will ever make it into production.

Despite the Pentagon [enjoying a nearly \\$1 trillion budget](#)—yes, you read that right—the Pentagon is somehow struggling to deter its global rivals while at the same time, failing to meet baseline recruitment standards. Now, they want more money and resources to do what they have been unable to do while already enjoying seemingly limitless resources and money.

It's time for the incoming Trump administration to hold the line against the wasteful Pentagon procurement programs. America doesn't need the [NGAD program](#) at all.

*[Brandon J. Weichert](#), a National Interest national security [analyst](#), is a former Congressional staffer and geopolitical analyst who is a contributor at The Washington Times, the Asia Times, and The-Pipeline. He is the author of *Winning Space: How America Remains a Superpower*, *Biohacked: China's Race to Control Life*, and *The Shadow War: Iran's Quest for Supremacy*. His next book, *A Disaster of Our Own Making: How the West Lost Ukraine*, is available for purchase wherever books are sold. Weichert can be followed via Twitter [@WeTheBrandon](#).*

UK, Italy, Japan to develop next-generation fighter jet



Delegates look at the Global Combat Air Programme (GCAP) 6th generation fighter jet concept design at the Farnborough International Airshow 2024© JUSTIN TALLIS

The UK, Italy and Japan on Friday launched a joint venture to develop a supersonic next-generation fighter jet by 2035, replacing the Eurofighter Typhoon.

Britain's BAE Systems, Italy's Leonardo and Japan Aircraft Industrial Enhancement Co Ltd (JAIEC) will each hold a 33.3 percent share in the new venture, "marking a pivotal moment for the international aerospace and defence industry," they announced in a press release.

JAIEC is a firm jointly funded by Mitsubishi Heavy Industries (MHI) and the Society of Japanese Aerospace Companies.

"Today's agreement is a culmination of many months working together with our industry partners and is testament to the hard work of everyone involved in this strategically important programme," said Charles Woodburn, BAE Systems Chief Executive.

The venture will "bring together the significant strengths and expertise of the companies involved to create an innovative organisation that will lead the way in developing a next generation combat air system, creating long-term, high value and skilled jobs across the partner nations for decades to come," he added.



GCAP aims to counter the threats posed by Russia and China and will merge two different aircraft programs -- the UK and Italy's 'Tempest' and Japan's 'F-X' © Handout

The three partners have agreed to form a new company under the Global Combat Air Programme (GCAP), a multinational initiative established by the UK, Japan and Italy in 2022 to develop a sixth-generation stealth fighter to replace the Typhoon and Japanese F-2.

The joint venture is expected to be established by the middle of 2025 and will undertake the design and development of the GCAP aircraft.

Italy's Defence Minister Guido Crosetto hailed the announcement as an "important step" and "a remarkable example of the strong international cooperation between our nations".

GCAP aims to counter the threats posed by Russia and China and will merge two different aircraft programs -- the UK and Italy's "Tempest" and Japan's "F-X".

The objective is to develop a twin-engine stealth aircraft that could be operated with or without a crew, would boast features such as laser-directed weapons and a virtual cockpit and would be much harder to detect using radar and infrared.

New technologies being explored for Tempest include the integration of AI and augmented reality and the ability to conduct missions alongside drones.

Visiting the Farnborough Air Show in July, where a model of the aircraft was unveiled, British Prime Minister Keir Starmer stressed "just how important a program this is" for the country.

But Mike Schoellhorn, the CEO of Airbus Defence and Space, said in July that the competition between GCAP and FCAS was "not logical".

Cingolani has not ruled out a possible rapprochement.

"I'm not saying merging, maybe this is too much, but for sure some collaboration. It's too early to say, we're just at the beginning," he told AFP.

Hybrid Aircraft Concepts Set to Change the Future of Flight

Hybrid aircraft are paving the way for a more sustainable future in aviation. By combining traditional engines with electric or alternative fuel systems, these innovative designs promise to reduce emissions, cut fuel costs, and improve efficiency. From commercial jets to regional planes, hybrid technology is set to transform air travel in the coming years. Here's a look at 8 groundbreaking hybrid aircraft concepts that are set to change the future of flight.



Boeing Subsonic Ultra Green Aircraft Research (SUGAR Volt)

© Image Editorial Credit: NASA/The Boeing Company / Wikimedia Commons

The SUGAR Volt, part of Boeing's green aviation initiative, proposes a hybrid propulsion system for greater fuel efficiency. Capable of switching between gas and electric power, this aircraft concept could reduce fuel burn by up to 70%. Its high-aspect-ratio wings further enhance aerodynamic performance. With this design, Boeing aims to balance environmental sustainability with operational cost savings.



Rolls-Royce Spirit of Innovation

© Image Editorial Credit: The wub / Wikimedia Commons

While Rolls-Royce's Spirit of Innovation is primarily an electric aircraft, its advancements in battery technology have implications for hybrid aviation. The project pushes the boundaries of electric propulsion, which could eventually be integrated into hybrid systems. By refining energy storage and propulsion

methods, Rolls-Royce is laying the groundwork for future hybrid aircraft. Their work signals a major step forward in reducing aviation's carbon footprint.



VoltAero Cassio

© Image Editorial Credit: Mike Burdett / Flickr

VoltAero's Cassio represents a new era of hybrid-electric aircraft, offering reduced noise and emissions for regional travel. This aircraft pairs electric motors with an internal combustion engine, providing extended range and increased operational flexibility. The Cassio is versatile, with the capacity to carry up to 10 passengers over 800 miles. Its quiet electric takeoffs make it especially appealing for noise-sensitive areas near airports.



Lilium Jet

© Image Editorial Credit: Mathious Ier / Wikimedia Commons

Though initially designed as an all-electric vertical takeoff and landing (eVTOL) aircraft, the Lilium Jet has the potential for hybrid evolution. By adding a hybrid propulsion system, the aircraft could extend its range and payload capacity for longer routes. Its unique distributed propulsion design makes it particularly suitable for urban air mobility, but hybrid technology could take it to the next level. Lilium's innovative design is already catching the attention of the aviation industry.



Eviation Alice

© Image Editorial Credit: Matti Blume / Wikimedia Commons

Kratos launches stealth drone Thanatos to boost fighter power



Thanatos - illustrative photo© kratos

Kratos Defense and Security announced the first flight of the Thanatos unmanned aircraft. Company representatives did not specify exactly when it took place. However, within the next 6-12 months, the company plans to further develop the drone. In the future, this machine will be a powerful support for American F-15 and F-16 fighters, enhancing their capability and strength.

Steve Fendley, president of Kratos's unmanned systems division, stated that the company is interested in the future development of CCA. Fendley believes that CCA-class drones significantly enhance the combat capability of fifth-generation fighters and increase the survivability of fourth-generation fighters. For example, "collaborative" drones enable the use of electronic warfare capabilities to extend the range for fourth-generation fighters, such as the F-15 and F-16.

Groundbreaking NASA battery will revolutionize air travel

In a groundbreaking development, NASA has unveiled a new solid-state sulfur [selenium battery](#) to revolutionize the aviation industry by replacing traditional gas-powered engines with electricity.

This innovative technology not only promises to significantly reduce harmful emissions but also opens up possibilities for faster and more efficient electric airplanes. In this article, we explore the implications of this breakthrough, its potential to transform air travel, and the challenges that lie ahead.

Air travel is a major contributor to [greenhouse gas emissions](#) and environmental pollution. According to the Environmental Protection Agency (EPA), commercial air travel in the United States alone accounts for 10% of transportation emissions and 3% of the nation's total greenhouse gas emissions.

Conventional jet engines rely on fossil fuels, releasing a wide array of pollutants into the atmosphere during flight. The urgent need to reduce the aviation industry's environmental footprint has driven researchers and engineers to seek alternative propulsion methods.

The SABERS activity is developing a solid-state battery for use in aviation applications. In this image, NASA researchers John Connell and Yi Lin (seated) are using a cyclic voltameter to check the performance level of a brand-new cathode the SABERS team created for their solid-state battery. (CREDIT: NASA)© The Brighter Side of News

Electric airplanes offer a promising solution to mitigate the environmental impact of aviation. Unlike their fossil-fueled counterparts, electric planes produce [zero emissions](#) during flight, making them a cleaner and more sustainable option. However, the adoption of electric aircraft has been hindered by several challenges, including limitations in battery technology.

The Energy Density Challenge

Electric airplanes require [powerful batteries](#) to generate the energy needed for takeoff and sustained flight. To achieve this, a battery must have a high energy density, meaning it can store a significant amount of energy per unit of weight.

Traditional lithium-ion batteries, commonly used in electric vehicles and consumer electronics, have a respectable power-to-weight ratio but fall short when it comes to meeting the demands of larger aircraft.

To put it in perspective, a battery for an electric plane would need an energy density of approximately 800 watt-hours per kilogram (about 363 watt-hours per pound) to make flight feasible.

Historically, the best [lithium-ion batteries](#) could only achieve an energy density of around 250 watt-hours per kilogram (about 113 watt-hours per pound), leaving a substantial gap in performance.

Another significant challenge associated with lithium-ion batteries is safety. These batteries contain flammable materials, posing a potential risk to aircraft in the event of a malfunction or fire. Ensuring the safety of passengers and crew is paramount in aviation, making the search for safer battery alternatives a top priority.



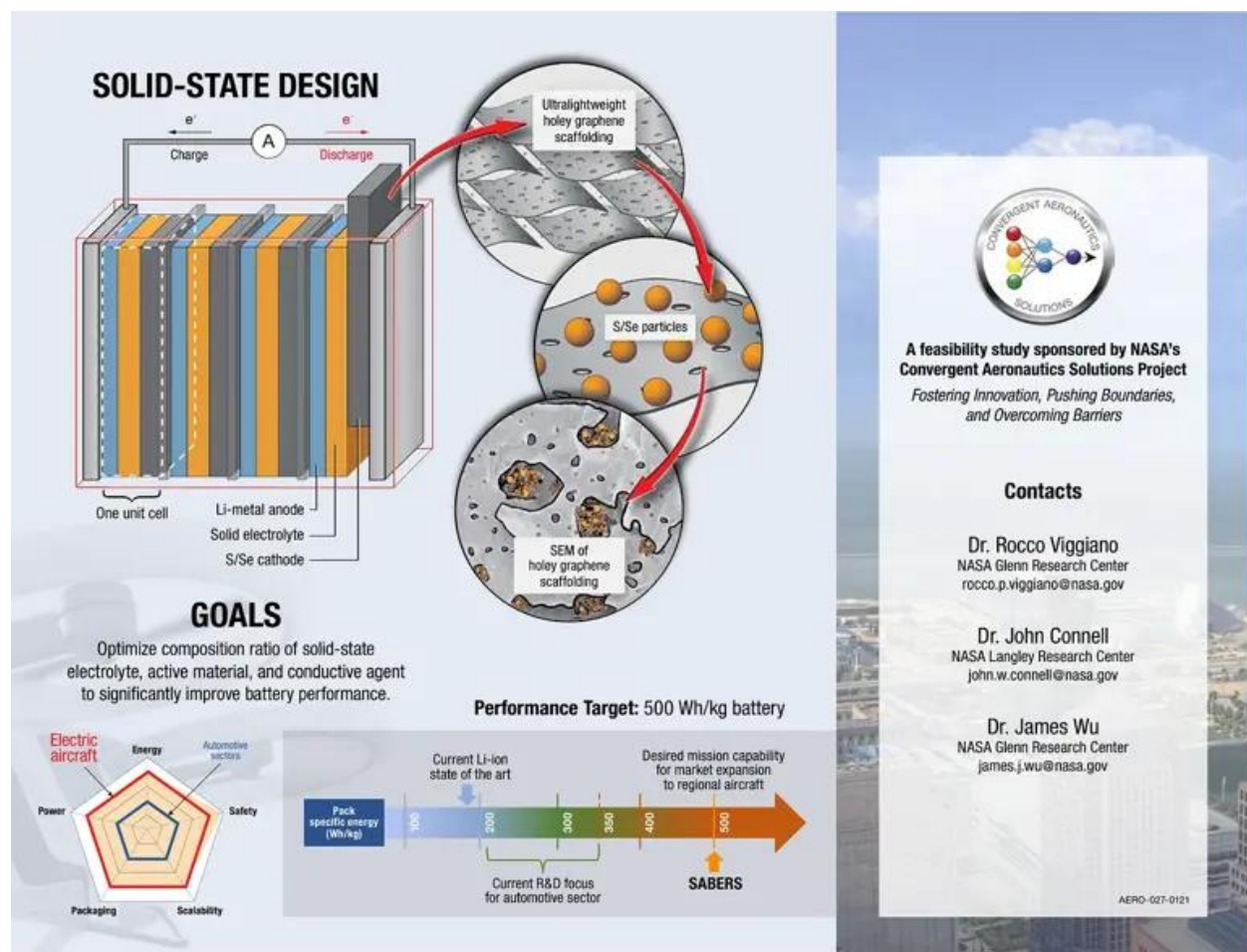
This illustration depicts the inside of a cell used in SABERS's solid-state battery, which is made primarily from sulfur and selenium. Unlike lithium-ion batteries, these cells can be stacked on top of one another without encasings to separate them. (CREDIT: NASA)© The Brighter Side of News

NASA's Solid-State Solution

In response to these challenges, NASA has been diligently working on its [Solid-state Architecture Batteries for Enhanced Rechargability and Safety \(SABERS\) project](#). The aim is to develop a battery technology that not only provides the required energy density for aviation but also enhances safety.

The sulfur selenium battery prototype developed by NASA's SABERS project represents a significant step forward. This solid-state battery maintains its structural integrity even when damaged, eliminating the risk of fire, which is a critical safety feature for aircraft.

Moreover, the prototype boasts an impressive energy density of 500 watt-hours per kilogram (about 227 watt-hours per pound), effectively doubling the energy density of traditional lithium-ion batteries.



Thanks in part to this novel design, SABERS has demonstrated solid-state batteries can power objects at the huge capacity of 500 watt-hours per kilogram – double that of an electric car. (CREDIT: NASA)© The Brighter Side of News

One of the key challenges in aviation is the rapid discharge of energy required for takeoff. NASA's sulfur selenium battery excels in this regard, discharging energy ten times faster than other [solid-state batteries](#).

While this rapid release of energy can lead to increased temperatures, the researchers found that the sulfur selenium battery could withstand temperatures twice as hot as those tolerated by lithium-ion batteries.

In addition to its safety and energy density improvements, NASA's research team managed to reduce the weight of their batteries by an impressive 40%. Lighter batteries can lead to more efficient aircraft, as they allow for increased fuel capacity. This, in turn, can extend the range and capabilities of [electric airplanes](#), making them more competitive with their traditional counterparts.

While NASA's sulfur selenium battery represents a remarkable breakthrough in battery technology, it will be some time before we see these batteries powering commercial airplanes.

The production of solid-state batteries remains costly, and any new aviation component must undergo rigorous testing and meet stringent safety standards before receiving approval for use in commercial flights.

By addressing the challenges of energy density and safety associated with traditional [lithium-ion batteries](#), this innovative technology could pave the way for cleaner, more efficient, and environmentally friendly aviation.

While there are still obstacles to overcome, the possibilities presented by this battery technology are nothing short of incredible, offering hope for a more sustainable future in air travel.

Fast-charging lithium-sulfur battery revolutionizes EVs and eVTOL aircraft

Lithium-sulfur (Li-S) batteries are emerging as a promising alternative for high-performance energy storage. Offering the potential for lighter, more energy-dense systems, these batteries are poised to revolutionize sectors like aviation,...

Published Nov 28, 2024 3:07 PM PST



Monash University has developed a groundbreaking lithium-sulfur battery that charges faster, lasts longer, and offers sustainable solutions. (CREDIT: adventtr/iStock)

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Lithium-sulfur (Li-S) batteries are emerging as a promising alternative for [high-performance energy storage](#). Offering the potential for lighter, more energy-dense systems, these batteries are poised to revolutionize sectors like aviation, electric vehicles (EVs), and renewable energy.

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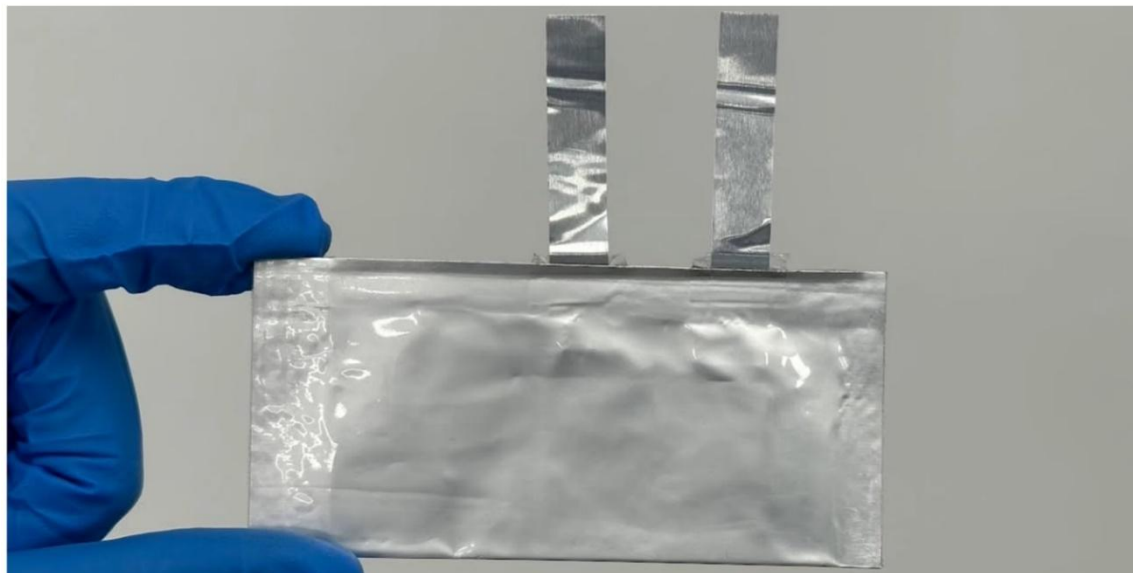
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Despite their potential, slow reaction kinetics during charge and discharge cycles have hindered their real-world applications—until now.

Researchers at Monash University have made a groundbreaking discovery in Li-S technology. By harnessing the unique properties of a polyvinylpyrrolidone (PVP)-iodine

binder system, they significantly improved the battery's reaction kinetics, allowing for faster and more efficient charging and discharging.

This innovation, published in [Advanced Energy Materials](#), marks a transformative moment in battery technology and paves the way for commercial applications.



A prototype lithium-sulfur (Li-S) battery developed by Monash University researchers. (CREDIT: Monash University)

The Science Behind the Breakthrough

The Monash team drew inspiration from the chemistry of betadine, a common antiseptic, to address the slow charge and discharge rates of Li-S batteries. A key innovation lies in the use of polyiodide species within a polar network of PVP. These complexes accelerate the transition between solid and liquid phases during [battery cycling](#), enhancing reaction pathways through inter-valence polyiodide reactions.

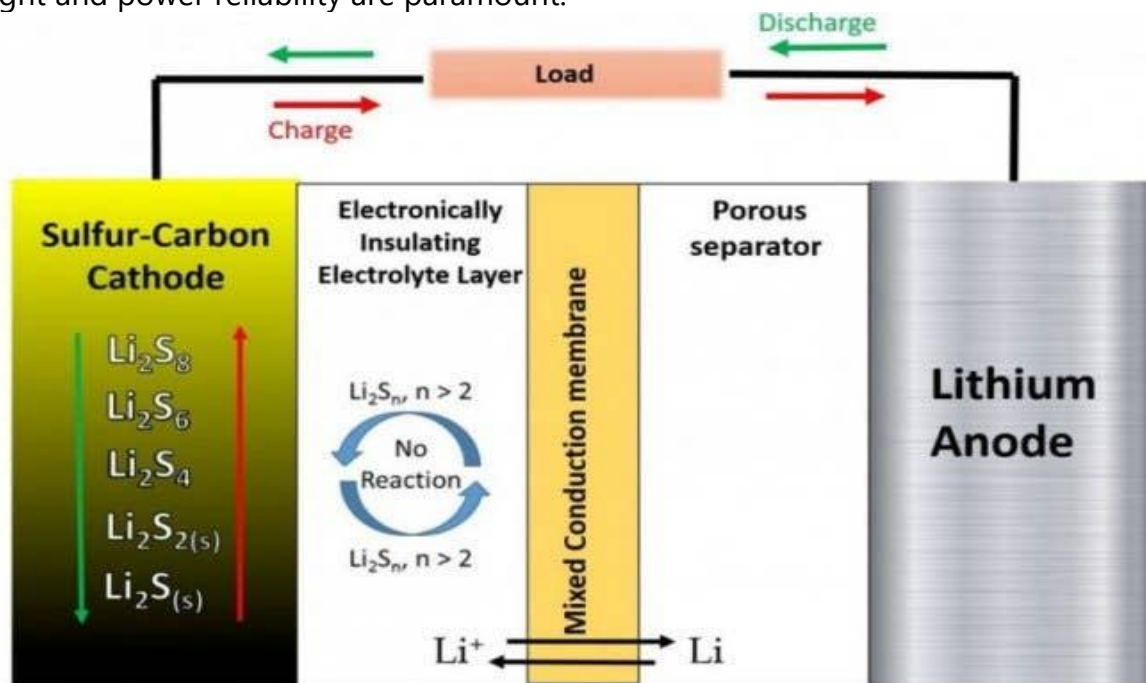
Density functional theory calculations revealed that the PVP-iodine complexes not only strengthen polysulfide binding but also introduce additional energy states. This combination accelerates the electrochemical reactions, overcoming a major bottleneck in Li-S technology.

The results are impressive: the improved batteries deliver an areal capacity of approximately 7 mAh/cm² at a practical 0.5C rate, while pouch cells achieve energy densities of 215 Wh/kg at 0.1C and 156 Wh/kg at 0.3C. These metrics position the Monash-developed batteries among the highest-performing Li-S prototypes reported to date.

Advancing Real-World Applications

According to Maleesha Nishshanke, the study's lead author, the batteries not only double the energy density of conventional lithium-ion cells but are also significantly lighter. "This advancement makes Li-S batteries a viable option for heavy-duty applications like [electric vehicles and drones](#)," she explained.

Co-lead author Dr. Petar Jovanović emphasized the transformative potential of this technology. "Li-S batteries could power long-haul EVs and commercial drones, while bringing sustainable electric aviation closer to reality," he noted. The lightweight design and high energy density are critical for industries like aviation and maritime, where weight and power reliability are paramount.



Basic construction of Li-S batteries. (CREDIT: CC BY-SA 4.0)

For electric vehicles, the implications are staggering. A single charge could power an EV for over 1,000 kilometers, with recharge times reduced to just a few hours. Dr. Jovanović illustrated the impact: "An EV could travel from Melbourne to Sydney on one charge, while [smartphones](#) could fully recharge in minutes."

A key challenge for Li-S batteries has been maintaining performance without rapid degradation. According to Professor Mainak Majumder, co-lead researcher and Director of the ARC Research Hub for Advanced Manufacturing with 2D Materials, the new design resolves this issue. "We've leveraged sulfur's unique chemistry to make a battery that's both safer and more efficient," he explained.

The team's novel catalyst enhances the C-rate performance, enabling batteries to handle high discharge rates during demanding activities like [take-offs in aviation](#). Early prototypes demonstrated energy densities up to 400 Wh/kg, showing promise for scaling up to larger commercial cells.

Beyond performance, Li-S batteries offer environmental advantages. Unlike lithium-ion batteries that depend on cobalt—a limited and often environmentally damaging resource—Li-S systems rely on sulfur, which is abundant and more sustainable. This makes the technology not only cost-effective but also eco-friendly.

Monash University researchers are on the brink of commercialising the world's most efficient lithium-sulfur (LiS) battery. (CREDIT: Monash University)

Economic Implications and Future Directions

As global demand for high-performance batteries surges, the lithium-sulfur market is projected to reach USD 209 million by 2028. Professor Majumder believes that [Monash's pioneering work](#) positions Australia as a leader in this burgeoning industry. "This emerging sector could create jobs, drive economic growth, and establish Australia as a key player in battery innovation," he stated.

The team continues to refine the technology, focusing on additives that could further enhance charging and discharging speeds while minimizing lithium requirements. These innovations aim to address the growing need for sustainable energy solutions in sectors ranging from consumer electronics to heavy industry.

Ghove Energy, a startup supported by the research team, is actively raising pre-seed funding to commercialize this breakthrough. Investors are being invited to participate in what could become a transformative venture for renewable energy storage.

The potential applications of this technology are vast. From powering long-haul EVs to enabling [electric aircraft](#), the possibilities are redefining the boundaries of what batteries can achieve. Supported by the U.S. Air Force Office of Sponsored Research, Monash's work demonstrates international recognition of its cutting-edge expertise.

As industries demand more efficient and sustainable energy solutions, Li-S technology offers a glimpse of a greener, more electrified future. By addressing critical challenges like charging speed and energy density, these batteries could soon become the standard for high-performance, sustainable energy storage.

UK, Italy and Japan Reach Landmark Agreement for GCAP Program



An infographic about the GCAP programme. (Image: UK MoD)

BAE Systems, Leonardo and JAIEC reached an agreement to form a new company under a business joint venture for the GCAP, building on the trilateral cooperation started in 2022.

The three national industry leads participating to the Global Combat Aircraft Programme (GCAP), BAE Systems, Leonardo and Japan Aircraft Industrial Enhancement Co (JAIEC), have reached an agreement to form a new company under a business joint venture and continue working on the program. The agreement builds on the strong trilateral government, defense and industrial cooperation between the U.K., Italy, and Japan since the GCAP was established in Dec. 2022 and its [collaboration](#) and [development](#) agreements both signed in late 2023.

"The new joint venture will be accountable for the design, development and delivery of the next generation combat aircraft and will remain the design authority for GCAP for the life of the product, which is expected to go out beyond 2070," the companies said in a [statement](#). As the program is based on the principle of equal sharing, the three main contractors will each hold a 33.3% share of the company.

The firm will be based in London, with the establishment date currently set for mid-2025. The company will initially have an Italian CEO, with operations and joint teams working in each of the [partner nations](#). The company being based in the U.K. will allow for "maximum alignment and collaboration" with the GIGO (GCAP International Government Organization), also based in the U.K.

According to Roberto Cingolani, the Chief Executive Officer and General Manager of Leonardo, "This partnership not only enhances our technological capabilities but also reinforces our commitment to global security and innovation."

Furthermore, the Chief Executive of BAE Systems Charles Woodburn commented that "The new business will bring together the significant strengths and expertise of the companies involved to create an innovative organisation that will lead the way in developing a next generation combat air system, creating long-term, high value and skilled jobs across the partner nations for decades to come."

The formation of a joint company in order to collaboratively produce new aircraft is in line with previous European aircraft development projects – namely [SEPECAT](#), which produced the Jaguar, [Panavia](#), which produced the Tornado, and most recently Eurofighter, who still produce the Typhoon combat

aircraft. Although the name of the company for GCAP has not been yet announced, we can expect it to be something iconic like SEPECAT, Panavia or Eurofighter.

The collaboration between the three companies will bring together their combined strengths and expertise. Although the individual companies have not serially produced their own aircraft, they have considerable experience in the field of advanced combat aircraft. In fact, Leonardo and BAE Systems are significant contributors to the U.S. F-35 program and manufacture certain parts of the jet, with the former also assembling the jets at its Final Assembly and Check Out (FACO) facility. Similarly, MHI (Mitsubishi Heavy Industries), under JAIEC, operates another FACO and also has experience developing the X-2 Shinshin stealth fighter demonstrator.



The X-2 Shinshin stealth fighter demonstrator. (Image credit: Japan Ministry of Defense)

The GCAP

The GCAP was established in December 2022, with a goal of developing a sixth-generation fighter plane for the three collaborating nations, the UK, Italy, and

Japan. The new aircraft will replace the Typhoons in service in the U.K. and in Italy, as well as the F-2s in service in Japan, [complementing the F-35s in service](#) in all three countries.

The program aims to deliver the capability to defeat the future threats with a targeted in-service date of 2035. Under GCAP, the three partner nations have agreed to pool their resources together, collaborating to produce a single common fighter jet that will go into service with the air arm of each country. The aircraft is expected to have a long service life, with an estimate of it still being active in the 2070s.

Previously, Japan had committed to building an indigenous F-X fighter, while the U.K. and Italy were collaborating on the Tempest fighter. Now that [Japan](#) has joined the coalition, the program is known as GCAP. A demonstrator airframe is expected to have its first flight sometime near the end of this decade.

The design of the aircraft, whose [1:1 mockup](#) appeared at Farnborough International Airshow earlier this year, seems to have a heavy focus on stealth, with a large, streamlined cropped delta wing and an angular, faceted design.



The new GCAP concept model. (Image credit: Leonardo)

The aircraft will be powered by two new engines, which will be jointly developed by Rolls-Royce (UK), IHI (Japan), and Avio Aero (Italy), while Leonardo (Italy and UK), Mitsubishi Electric (Japan), and ELT Group (Italy) are in charge of developing its onboard sensors.

According to BAE Systems, the aircraft will have an "advanced intelligent weapons system, software-driven interactive cockpit, integrated sensors and a powerful next generation radar capable of providing 10,000 times more data than current systems, giving it a battle-winning advantage."

The aircraft's sensors and systems have started testing on the Excalibur, a 757-based test airframe that [was recently seen with its first modifications](#). It is a rough equivalent to the US' Catfish, also a modified 757 passenger aircraft, which tests the systems for F-22 fighter jets.

"With electrification and the development of AI, we will probably see a significant increase in the world's energy needs. That electricity needs to come from environmentally sustainable sources if we are to slow down climate change at the same time," says Feng Gao, professor of optoelectronics at LiU.

One green energy source in the focus of researchers globally is solar cells. As a complement to traditional silicon solar cells, several different alternative variants are being developed. One of the most promising technologies is based on electrically conductive plastics—organic electronics.

The advantage of organic solar cells is that they are comparatively cheap and easy to manufacture. In addition, they are lightweight and flexible, which means that they could be placed on windows, indoors or on clothes to power personal electronics. Organic solar cells are already on the market today and their share is expected to increase.

Feng Gao, professor of optoelectronics at Linköping University. Credit: Thor Balkhed

What the Linköping researchers have done is map the molecular interaction between the materials transporting the electrons and the solvent itself by using a series of advanced synchrotron X-ray and neutron techniques. Thanks to this, the researchers were then able to develop a design principle that works for many

different harmless solvents. In the long run, they hope that even water can act as a solvent.

The Shape Of Wings To Come

U.S. military aircraft may one day mimic the Hollywood special effects of *Batman Begins* with wings that change from pliable to rigid and back again or that expand and contract on demand. Two approaches for morphing aircraft structures are being considered that would give the armed forces the ability to use the same airplane in multiple roles, from slow-flying reconnaissance missions to high-speed target takedowns. Several enabling technologies are facilitating the development of this capability; however, determining how such aircraft would meet military requirements still remains to be done.

BY MARYANN LAWLOR

OCT 01, 2006



Lockheed Martin Aeronautics

Company's Advanced Development

Programs sector is proposing a morphing wing design that can be locked into either an expanded or contracted position. Key to enabling this capability is the aircraft's skin, which is made out of a shape memory polymer.

Morphing capability would offer flexible tactical options.

U.S. military aircraft may one day mimic the Hollywood special effects of *Batman Begins* with wings that change from pliable to rigid and back again or that expand

and contract on demand. Two approaches for morphing aircraft structures are being considered that would give the armed forces the ability to use the same airplane in multiple roles, from slow-flying reconnaissance missions to high-speed target takedowns. Several enabling technologies are facilitating the development of this capability; however, determining how such aircraft would meet military requirements still remains to be done.

Researchers at the Defense Advanced Research Projects Agency (DARPA), Arlington, Virginia, have been exploring the possibility of shape-shifting aircraft for some time. But Dr. Terrence A. Weisshaar explains that the early morphology work involved only changing the wings' camber. This ability provided limited new capabilities—not much more than already could be accomplished using flaps. Weisshaar had served as the program manager for DARPA's Morphing Aircraft Structures (MAS) effort when the project was resurrected more than four years ago. He has since returned to his position as a professor of aeronautics and astronautics at Purdue University.

The agency decided to revisit the morphing aircraft concept in April 2002 with a three-phase program. The first two phases of the MAS program aimed at attaining four technical goals: innovative, active wing structures that change shape; integration and aeronautical use of advanced sensors, skin and structure materials, internal mechanisms and distributed power sources; advanced capabilities for the military community; and advanced shape-changing materials, efficient actuators and sophisticated, smart mechanisms.

For the one-year first phase of the project, DARPA awarded contracts to three firms, and each took a unique approach. Palmdale, California-based Lockheed Martin Aeronautics Company's Advanced Development Programs section, also known as Skunk Works, designed an aircraft wing that can fold and be locked in two positions. The structural material, called a shape memory polymer, becomes pliable when stimulated with a moderate amount of current, then returns to a solid state when the stimulus is terminated.

Engineers at NextGen Aeronautics Incorporated, Torrance, California, took a different tack. Their in-plane morphing approach increases the wing surface by using innovative materials put together in a proprietary way, multiple actuators and a computer control system that affect the shape shifting. The wings can expand and contract to multiple positions.

Raytheon Missile Systems, Tucson, Arizona, chose to design morphing wings for cruise missiles rather than for manned or unmanned aircraft. One possible

application would be in submarines where the missiles would be stored in tubes with folded wings that would be extended once in flight.

Weisshaar explains that creating a truly morphing aircraft requires that changes can be made in the wing area, span, sweep and thickness. While a minimum of wing area is needed to fly at speeds of Mach 2 or Mach 3, a larger wing is necessary for landing. "So you already have a problem. If you want to go really fast, then you can't land very efficiently. What we said is 'let's change the wing area,' and it turns out that [an increase of] 50 percent is a pretty good number. If you could change the wing area in flight by 50 percent, you can do lots of different things. You can operate efficiently at high speeds and at low speeds," he relates.

Flying high and slow—an appealing capability for reconnaissance missions—requires a wide wingspan in addition to a larger wing area, so increasing the wingspan by 50 percent to 75 percent also multiplies applications. "The aircraft could hang out at high altitudes, but it could still respond supersonically or at least high subsonically to a threat. This is a big deal for the military," Weisshaar notes. "Our goals in this morphing program were to get big area changes, as big as 50 percent; big span changes—50 percent to 75 percent—and then also sweep changes because that is something that you want for high speed."

During the first phase of the program, contractors were required to define the concepts fully and then to test and demonstrate critical components. All three companies were successful to a major degree, he states.

DARPA chose to pursue work with Lockheed Martin and NextGen Aeronautics for the 18-month second phase of the project, opting to concentrate on unmanned aerial vehicles (UAVs) rather than including cruise missiles in the effort. The goal during this stage was to develop the remaining companies' designs and demonstrate them in an aeronautical environment. To conduct the examinations, prototype planes were taken to the transonic dynamics tunnel at NASA's Langley Research Center in Hampton, Virginia.

"The issue here is not so much aerodynamics, because you can predict lift and drag pretty well. It wasn't even structure loads or static loads, because you can pretty well predict those. The real issue was could you build a system that could transition radically from one shape to another very, very different shape without the whole thing coming apart," Weisshaar explains.

Using a model that was half the size that DARPA had in mind for the potential real-world aircraft, the agency team determined that the morphed wings could hold their shapes within a couple of degrees. In addition, the wings could be unlocked at

speeds of nearly Mach 1. The tests not only included low and high speeds but also low and high altitudes—from sea level to 50,000 feet.

After some minor adjustments to address billowing problems, Lockheed Martin demonstrated that its design skin could stretch 100 percent. And, while NextGen Aeronautics' original design resulted in a few tears in the skin when loads were increased, a minor design alteration resolved the problem, and the plane reached speeds of Mach 0.9 without additional problems. "The bottom line was that we did it," Weisshaar states.

Larry Dilger, manager, Morphing Air Structures, Lockheed Martin Aeronautics, explains that his group's work on the project began with identifying the key enabling technologies that would result in a revolutionary improvement in aeronautical performance. The team, which currently consists of 15 people, singled out three enabling technologies as crucial to developing the design. The first was the airplane's skin, which is necessary to conceal discontinuities on aircraft such as hinges and doors that restrict performance.

Dilger says that although the technology is still somewhat in the embryonic stage, Lockheed Martin developed a shape memory polymer that resembles fiberglass. It is about an eighth of an inch thick and is embedded with elements that allow current to pass through it to allow shape changes.

The actuation of structures was the second key enabling technology the team identified. "You might imagine that folding a wing is not a trivial task, and traditionally rather large, very heavy actuation mechanisms were used to do that. For example, a carrier-capable aircraft has wing-folds on it that are very, very heavy—not very efficient for today's aircraft," Dilger offers.

The third capability the team identified was technologies that would enable control of the aircraft in flight. "One of the most exciting enabling technologies that we're dealing with on this program has to do with adaptive flight controls. A morphing aircraft can really do the same thing as well as a variety of aircraft. For example, a U-2 flies high and slow for long hours and gathers a lot of data. An F-117 or an F-22 flies fast and is highly lethal. Both of those airplanes have optimized designs.

"What morphing aircraft structures represent is the ability to become either a persistent reconnaissance platform or a highly lethal combat platform. And, there are many other missions—for example, homeland defense, border patrol and harbor patrol," he notes.

The company successfully developed these three key enabling technologies for the first phase and validated them during the second phase of the DARPA project, but Dilger admits that work remains. Currently, these capabilities are at technology readiness level (TRL) 2 or 3 and will need to mature to TRL 7 or 8 before they will ever excite a military general, he says. “That’s the biggest challenge—getting people to believe it’s possible,” he adds.



NextGen Aeronautics’ morphing aircraft design features wings that can continuously change shape to increase the wings’ surface area.

While Lockheed Martin’s team chose a two-position folding wing design, NextGen Aeronautics decided to develop an in-plane morphing approach. This design expands the wings’ area surface incrementally to provide the most efficient shape required for an aircraft’s role in a mission. Jay Kudva, president and chief executive officer, NextGen Aeronautics, explains that the toughest technical challenge in the company’s concept was developing airplane skins that can stretch an enormous amount yet continue to handle loads without tearing. “Nobody’s ever done a flexible skin that expands this much—ours expands more than 100 percent for landings—and still [can] take air loads and fly,” Kudva claims.

Proof of the firm’s design concept was attained this summer apart from the DARPA program. The company constructed a 100-pound jet-powered remote-control model that completed a successful flight in August. “We tested this a couple of times late last year and early this year. We were not successful in landing it well at that time. Let’s say we had an unconventional landing a couple of times. But on August 1st [2006], we flew it and we successfully showed, for the very first time, that it could stretch the skins and morph in flight pretty quickly—within a matter of 5 or 10 seconds. And we changed the wing area by about 40 percent, and we changed the wing sweep from about 15 degrees to 35 degrees,” he says.

Although the company's team considers this first flight of a morphing aircraft a remarkable accomplishment, the innovators in this small company already are thinking about how shape-shifting aircraft could sport even more capabilities in the future. "We're working on other technologies to integrate antennas into the structure itself. The aircraft skin, or large segments of the airplane skin, would become antennas that can take all the airplane loads and shape yet still perform their necessary functions. So one potential longer term vision is that expanding the skin not only gives you improved aerodynamic performance, it gives you a larger antenna to use for surveillance. Then you fold it up to conduct other functions such as attack a target, for example," Kudva relates. This capability is probably years away, he emphasizes.

Phase three of the DARPA program began in May, and Weisshaar relates that the agency has contracted with another Skunk Works team to build three Polecat UAVs for this stage of the project. Unveiled this summer at the Farnborough International Air Show in England, the UAV can fly at high altitudes and was developed to learn more about the flight dynamics of a tailless unmanned air system.

Weisshaar, Kudva and Dilger all agree that while the advancements that are enabling wing shape shifting are exciting, the real triumph of morphing aircraft will be the agility and flexibility they could offer the military. Rather than building several types of aircraft to fulfill different mission requirements, one airplane would provide reconnaissance and attack capabilities even for fast-moving targets.

Dilger explains why he believes this is so important. "What really excites us about this is that it opens up a lot of new opportunities. We cannot continue to buy the same number of airplanes in the future that we've done in the past. We're not going to have pilots, and we can't afford the cost. So you're going to have to get more bang for every buck, and we believe this is a way to do it," he says.

By the end of August, DARPA already had reviewed each team's preliminary designs for phase three. The first flight demonstrating the NextGen Aeronautics' morphing aircraft is scheduled for January 2007, followed by Lockheed Martin's in February 2007. Phase three will contractually end in April 2007.

Lockheed Martin can grow the skin of an aircraft that contains sensors & stores energy, without any wires. Data flows through the structure. They have new materials that change shape on command, like a muscular material.

Lockheed Martin openly talking about skin growing technology for aircraft

Lockheed Martin has talked about developing a technology that acts like a skin and can grow on the outside of aircraft, but this is something they've been working on for years. Makes you wonder what kind of tech they have now if this was an older project.

It feels like, as time goes on, more of these little bits of info that get released end up being told.....

Lockheed Martin has developed new technology that can grow a sensor-embedded, energy-storing aircraft skin, all without the use of wires. Their innovative materials can also change shape on command. As a leading global security, defense, and aerospace contractor, Lockheed Martin ensures that its clients remain ahead of readiness.

Groundbreaking new jet engine generates thrust directly from electricity



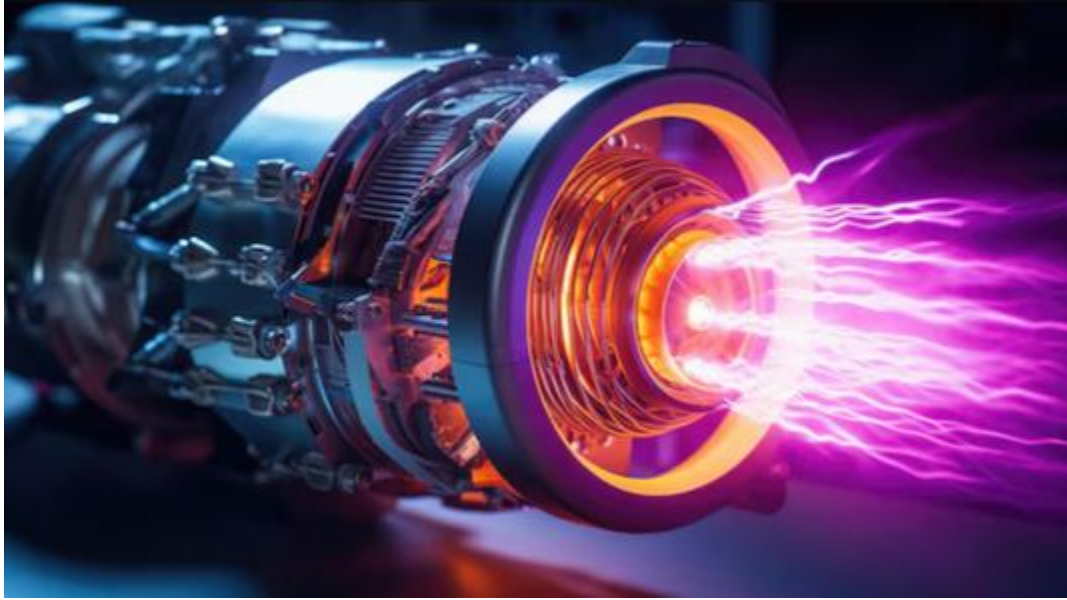
Researchers have developed a prototype jet engine powered by microwave air plasmas, offering thrust without fossil fuels. (CREDIT: CC BY-SA 4.0)© The Brighter Side of News

The global reliance on fossil fuels, particularly in transportation, has severe consequences for the environment and public health. Fossil fuels are a leading source of greenhouse gas emissions, driving climate change and impacting respiratory health.

A groundbreaking development from [Wuhan University](#), however, hints at a future where jet propulsion depends entirely on electricity and air.

The Fossil Fuel Challenge

Transportation is vital for modern life, but its dependence on fossil fuels comes at a significant environmental cost. The combustion of these fuels powers vehicles, planes, and industrial equipment while contributing nearly 29% of greenhouse gas emissions, according to the [Environmental Protection Agency](#). The urgent need for sustainable alternatives has spurred innovation.



Plasma Jet Engines Could Revolutionize Aviation and End Fossil Fuel Dependency. (CREDIT: Freepik)© The Brighter Side of News

Professor Jau Tang and his team at Wuhan University have developed a prototype jet engine powered by microwave air plasmas, offering thrust without fossil fuels. This revolutionary approach could transform air travel by eliminating carbon emissions.

“Our work aims to solve global warming problems by replacing [fossil fuel combustion engines](#),” Tang explained. “With our design, there is no carbon emission to cause greenhouse effects and global warming.”

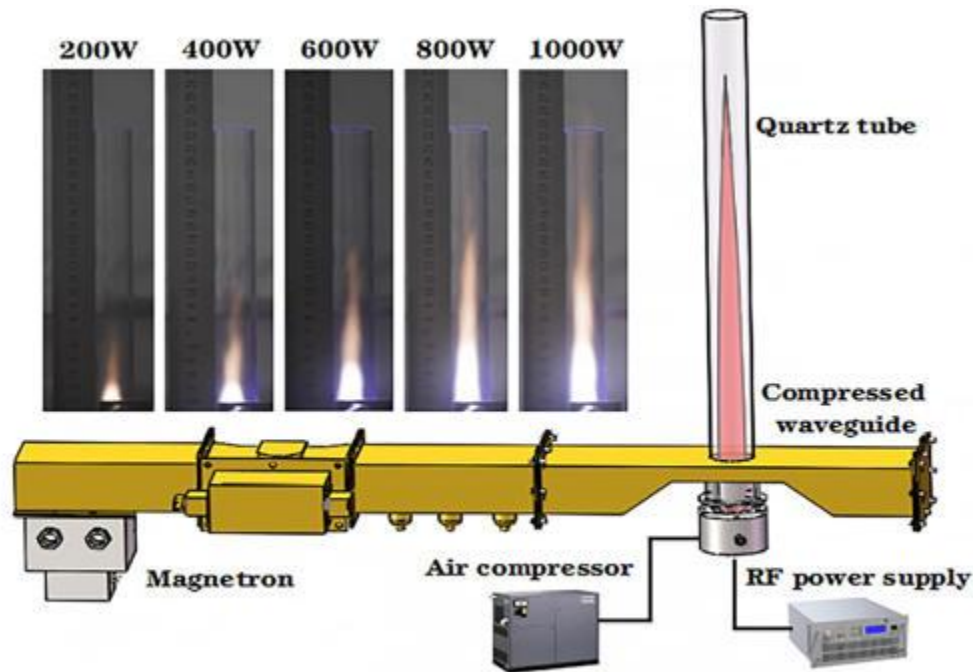
How Plasma Powers the Engine

Plasma, the fourth state of matter, consists of charged particles like ions and electrons. Found naturally in the sun and lightning, it can also be generated in controlled environments. Tang's engine harnesses this state of matter through a sophisticated process involving air compression and microwave technology.

Here's how it works:

- **Air Compression:** The system starts by drawing in atmospheric air, which is then compressed to high pressures using a turbine compressor. This [compressed air](#) provides the necessary density for effective plasma generation.
- **Microwave Ionization Chamber:** The compressed air flows into a quartz tube fitted with a microwave ionization chamber. Microwaves, operating at 2.45 GHz—the same frequency used in microwave ovens—are directed into this chamber.
- **Ionization:** Inside the chamber, the high-frequency microwaves excite the air molecules, stripping electrons from the atoms and creating a [plasma state](#). The resulting plasma reaches temperatures exceeding several thousand degrees Celsius.
- **Jet Thrust Generation:** The high-temperature plasma rapidly expands as it exits the ionization chamber. This expansion produces a jet thrust capable of lifting a 1-kilogram steel ball, demonstrating thrust comparable to conventional jet engines.

Tang's approach differs from other plasma propulsion systems, such as those used by [NASA](#). For example, NASA's xenon-based plasma thrusters, like those on the Dawn spacecraft, work well in the vacuum of space but are ineffective in Earth's atmosphere due to their low thrust output. Tang's design overcomes this limitation by using atmospheric air, making it feasible for terrestrial and airborne applications.



A schematic diagram of a prototype microwave air plasma thruster and the images of the bright plasma jet at different microwave powers. This device consists of a microwave power supply, an air compressor, a compressed microwave waveguide and a flame ignitor. (CREDIT: Jau Tang and Jun Li)© The Brighter Side of News

The Road to Scalable Plasma Jets

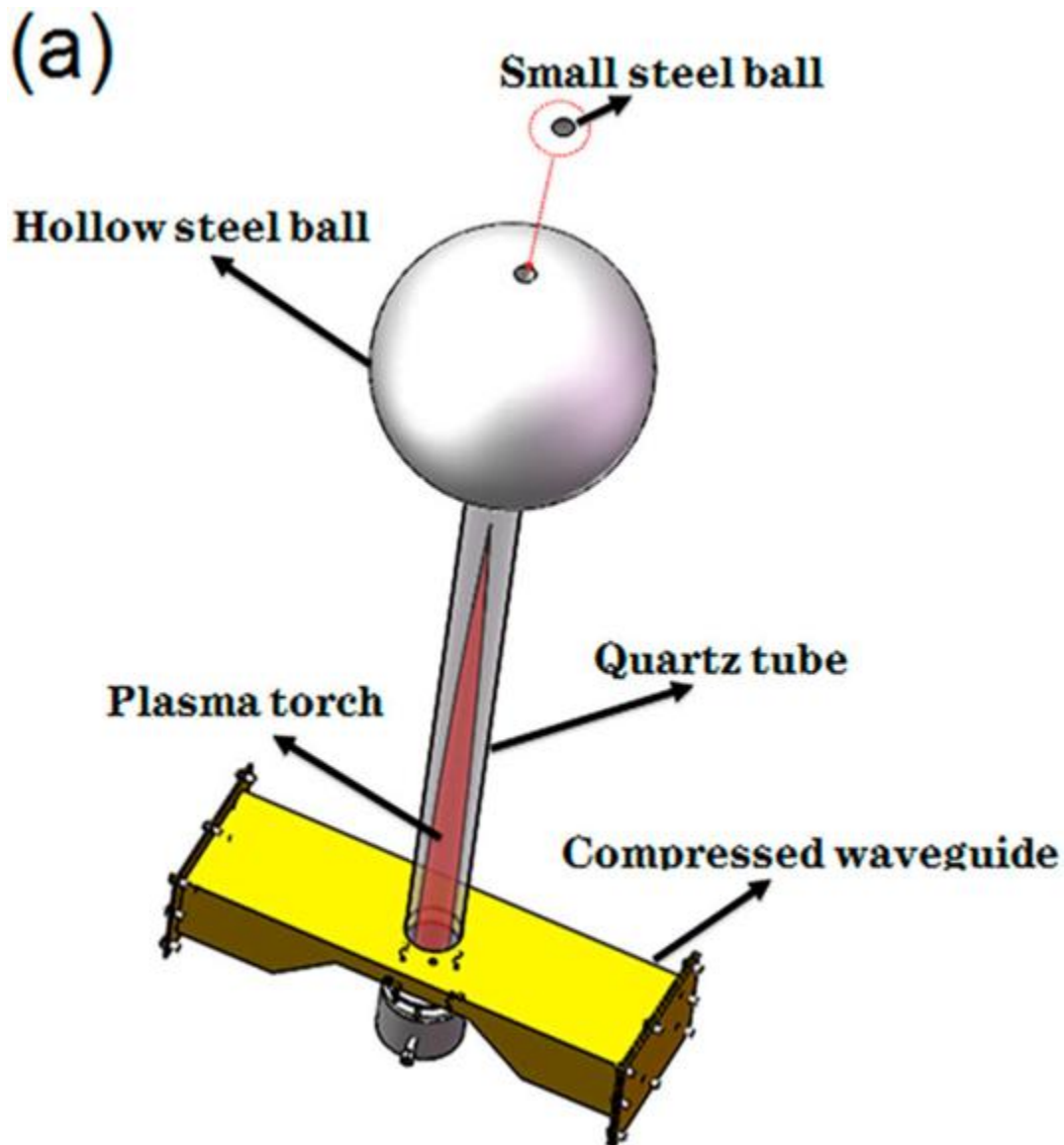
While the prototype is promising, scaling it to power large aircraft presents unique challenges. The current design requires megawatt-level microwave sources and advanced energy storage systems capable of delivering continuous high power.

“For a [large jumbo jet](#), development could take another decade,” Tang estimated. Scaling up involves integrating multiple plasma jet modules in a parallel configuration. This would increase the overall thrust while maintaining efficiency.

The prototype already achieves a jet pressure of 24,000 newtons per square meter with 400 watts of power, comparable to commercial aircraft engines. However, larger aircraft will require significantly higher power outputs, which demands advancements in battery technology.

Tang believes smaller-scale applications, such as heavy-duty drones or pilotless cargo planes, could become operational within five years. These aircraft would be

ideal for logistics and delivery services, [reducing emissions](#) in the transportation sector.



Schematic diagram of a simple homemade heat-resistant device for the propulsion pressure measurements, consisting of a hollow steel ball on top of the quartz tube. The device has a small hole at the top for inserting smaller steel beads in order to adjust the threshold weight at which the ball starts to rattle due to the effect of the plasma jet. (CREDIT: Jau Tang and Jun Li)© The Brighter Side of News

However, even for these smaller applications, challenges remain. The high energy density required for sustained flight means that current battery technologies must evolve to be lighter and more efficient. Weight is a critical issue, as heavy batteries could negate the benefits of this zero-emission propulsion system.

Addressing Engineering Challenges

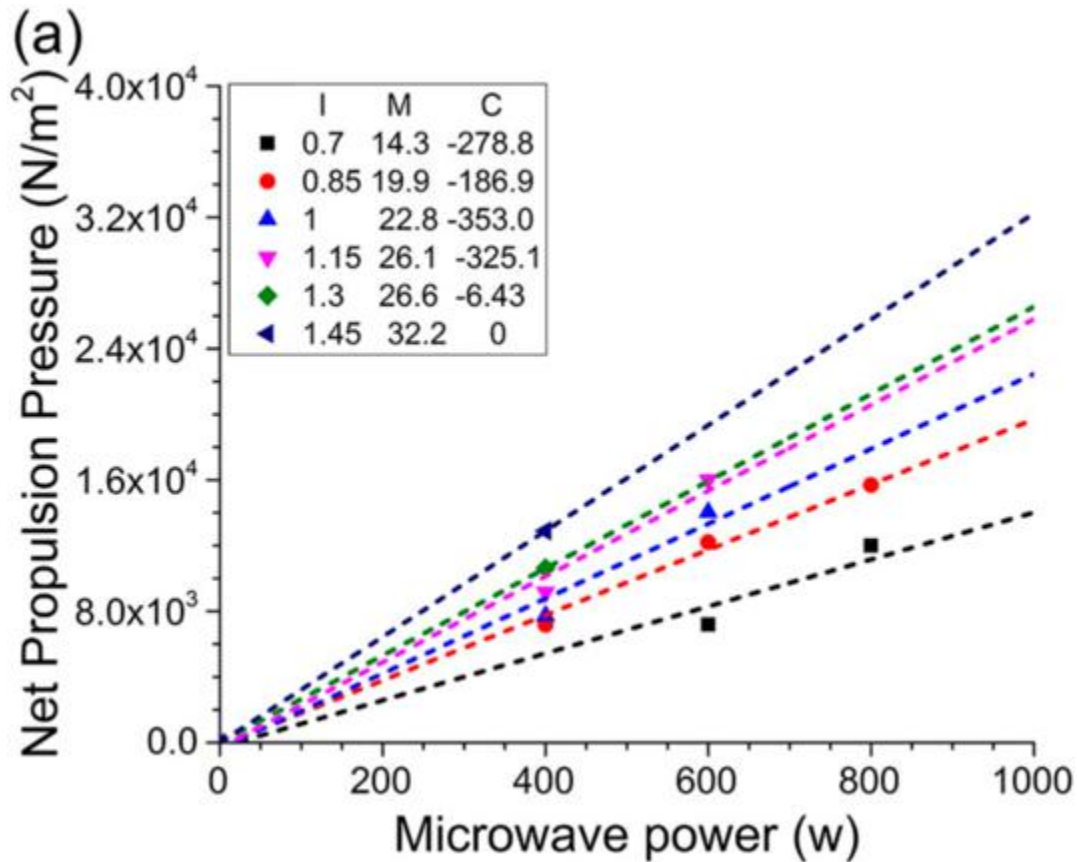
Another hurdle is thermal management. [Plasma engines](#) generate extreme heat, which can damage engine components over time. Tang's team is investigating advanced materials and cooling systems to mitigate these effects.

"We still need to improve the engine's efficiency and address the impact of high temperatures on the equipment," Tang noted. "Managing the heat and ensuring durability under continuous operation are our next big challenges." Additionally, achieving stable and controlled thrust across different flight conditions is crucial. The team is optimizing the flow dynamics within the ionization chamber to ensure consistent performance.

A Vision for the Future of Air Travel

Despite the challenges, Tang remains optimistic. His research has garnered attention from the global scientific community, with many experts recognizing its potential to revolutionize aviation. If successful, [plasma jet engines](#) could lead to a new era of sustainable air travel, free from the environmental and geopolitical constraints of fossil fuels.

"Our results demonstrate that a microwave air plasma jet engine could be a viable alternative to conventional fossil fuel engines," Tang said.



Net jet pressure (excluding the contribution from the injected air but with no microwave power) at various air flow settings as a function of the microwave power (in a unit of W). Linear fits were obtained with m representing the slope and c representing the y-axis intercept. I represents the air flow rate (in a unit of m^3/h). (CREDIT: Jau Tang and Jun Li) © The Brighter Side of News

While it may take years before you see plasma-powered planes in the sky, the foundation is being laid for a future where [aviation is cleaner](#), quieter, and more sustainable. Tang's groundbreaking work not only promises a solution to climate change but also redefines what's possible in propulsion technology.

‘Son of Concorde’ supersonic jet set to make first test flight



A new supersonic jet could be taking to the skies in the not too distant future.

Boom Supersonic’s XB-1 experimental prototype has undergone extensive ground testing over the past few months.

Fast approaching the final stages of testing, the prototype’s set to take its first test flight before the end of the year.

The testing is helping ready the aviation company’s Overture aircraft, dubbed the “Son of Concorde”, for its first flight in 2029.

Apparently, Overture will be able to fly passengers from the United Kingdom to the United States in just three and a half hours.

The jet, which features four engines and a new fuselage, will be able to fly at supersonic speeds of up to 1,304 miles per hour.



To be precise, the aircraft will cruise at Mach 1.7 over water and just under Mach 1 over land.

The new supersonic jet won't just fly between the UK and US, though.

More than 600 routes have been planned from Overture across the globe.

Last year, American Airlines confirmed its partnership with the company to create aircraft that could travel at "2x the speed of today's fastest commercial jets".



“Aviation has not seen a giant leap in decades,” [Boom](#) founder and CEO Blaske Scholl previously said in a statement.

“Overture is revolutionary in its design, and it wil fundamentally change how we think about distance,” he added.

It goes without saying, test-flkying the prototype is an important milestone for the company, which has ambitions of developing both sustainable and supersonic flights.



Boom Supersonic

“I believe in a future where more people go more places,” Scholl recently told Yahoo.

“Think about crossing the Atlantic in under four hours, leaving the East Coast in the morning, and making it to a dinner meeting in Europe on the same day,” he added.

“Think about being able to do a roundtrip to Asia in 24 hours.”

US Navy's hypersonic vehicles to get GPS-free navigation boost from Anello Photonics



US Navy's hypersonic vehicles to get GPS-free navigation boost from Anello Photonics

Anello Photonics, a leading firm in silicon photonics technology, has been awarded a contract by the US Navy to develop a cutting-edge navigation system to help hypersonic vehicles operate even in GPS-denied environments.

"Anello was selected for a Small Business Innovation Research Phase I due to its innovative optical gyroscope technology and its unique sensor fusion engine," the company informed.

The company's Silicon Photonics Optical Gyroscope (SiPhOG) technology and sensor fusion engine aim to bring significant advances in navigation.

"This will ensure that the US Navy platforms can maintain high-accuracy navigation in challenging GPS-denied situations," said the company.

Overcoming GPS reliance

SiPhOG is a compact, ultra-lightweight, and high-performance optical gyroscope. It promises to deliver accurate guidance even when the Global Positioning System (GPS) signals are unavailable or compromised.

Traditional navigation systems often rely heavily on GPS. However, in contested environments where hypersonic vehicles operate, GPS signals can be easily disrupted or denied by adversaries.

Anello's SiPhOG technology offers a unique approach to navigation in GPS-denied environments.

In typical operations, a loss of GPS signal often triggers a failsafe mode in the autopilot system. This can lead to undesirable outcomes such as hovering in place, an emergency landing, or even a crash.

However, with Anello's SiPhOG technology, specifically demonstrated in their recently launched Anello X3, the system can seamlessly detect GPS signal disruption.

Instead of resorting to a failsafe mode, the SiPhOG gyroscope provides continuous and accurate navigation data, allowing the vehicle to maintain controlled flight even in the presence of [GPS jamming](#).

Precise navigation for hypersonic vehicles

The technology employs the principles of [interferometry](#) to precisely measure a vehicle's rotation and orientation.

Within the SiPhOG, laser light travels through a microscopic waveguide etched onto a silicon chip. This chip also contains integrated optical components that manipulate the light, creating interference patterns. By analyzing these patterns, the SiPhOG can determine the vehicle's precise movements with exceptional accuracy.

Under the latest contract, the company will focus on demonstrating the capabilities of SiPhOG and the sensor fusion engine over a six-month period.

If successful, the project will progress to Phase II, which will involve developing a prototype navigation system and rigorous testing in simulated hypersonic flight conditions.

Phase III aims to [integrate](#) the prototype onto a representative hypersonic vehicle for demonstration and assessment during Advanced Naval Technology Exercise (ANTX) events.

Developmental efforts for GPS-free navigation

Amid the increasing geopolitical tensions and the use of new war technologies, the requirement for GPS-free hypersonic vehicles has intensified. This latest award by the US Navy reflects the same broader trend.

“Within this program, the U.S. Navy can directly evaluate and experience first-hand the benefits of the Anello products for navigation in GPS-denied or contested environments,” [concluded](#) Dr. Mario Paniccia, CEO of Anello Photonics.

Notably, several studies have been conducted in this regard. Recently, the Sandia National Laboratories of the US developed “the [mother of all motion sensors](#)”, which aims to enable GPS-free navigation for air defense vehicles.

Besides, Sydney-based Advanced Navigation has partnered with MBDA to develop a system that will allow drones to soar high in the sky and navigate without GPS.

China tests new Mach 4 turbojet engine, that could be used in PLA spy planes



China tests new Mach 4 turbojet engine, could be used in PLA spy planes

Chinese scientists from the Taihang National Laboratory, an aerospace research institution located in southwest region of the country, have completed ground tests on a new superfast turbojet engine. According to reports, the new engine incorporates artificial intelligence (AI) and can reach speeds of up to Mach 4.

The engine and research behind it are part of China's quest to build fast reconnaissance aircraft similar to the America's legendary Lockheed Martin SR-71 'Blackbird'. Capable of flying at the speed of sound on altitudes of over 85,000 feet, the aircraft made aviation history.

First developed in the 1960s, this iconic 'Blackbird' could reach speeds of Mach 3.2 and served with distinction until its final retirement in 1999. Since then, no viable replacement has been developed by any nation, but if reports are accurate, China could be closer than most.

China's answer to 'Blackbird'?

The turbojet engine features a dual-mode design similar to the J58 engine used on the 'Blackbird'. The Taihang National Laboratory is well placed for such research, being China's primary developer of advanced engines. The laboratory responsible for developing China's Taihang series engines that power advanced fighter jets like the J-20.

According to a [report](#) in the *South China Morning Post (SCMP)*, the latest engine technology uses turbines to compress air for efficient combustion at low speeds and opens an additional air intake during high-speed cruising to allow air to go straight into the combustion chamber for higher thrust.

To this end, the scientists developed an "enhanced high-Mach adaptive model" to improve the engine's performance, enabling it to work "smartly" under nearly all operating conditions. This, in part, helps the design meet the [People's Liberation Army's \(PLA\)](#) "engineering application requirements," the team explained.

The development process, however, was not without challenges. One major issue the team faced was the discrepancy between the onboard computer's estimation of the engine's status and the actual situation, which can affect engine control significantly.

"In practical applications, there is a deviation between the on-board real-time model's estimated output and the true output," the research team wrote in its paper published in the Chinese journal *Propulsion Technology*. This was mainly because engine parts are marginally different from design values due to manufacturing and installation uncertainties.

AI included as standard

The team also noted that engine components' performance can also decline over time. This is a long-standing issue for many aircraft, including the 'Blackbird', which often suffered engine oil leaks due to widening gaps between parts. Such

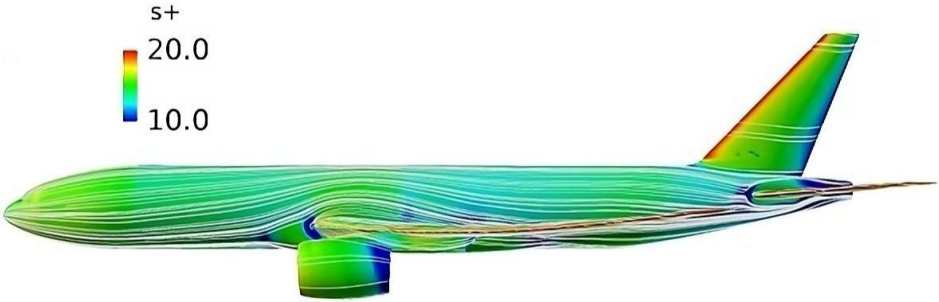
issues are difficult to address through computer simulations. However, manufacturing precision and quality control have significantly improved over the past few decades. This allowed the research team to conduct varying experiments in order to gather error data and use it to enhance model accuracy.

The team developed a unique artificial intelligence (AI) algorithm that enables military chips to undertake a large number of complex calculations in a short time. "The model can track and estimate engine characteristic parameters and health parameters online in real-time with high accuracy, proving high engineering application value," the team wrote.

More fuel-efficient planes with this "shark skin" paint

Published January 29, 2025 at 06:00 AM

What if shark skin held the secret to reducing the environmental impact of planes? Japan Airlines is testing a paint that mimics the scales of these marine predators, hoping to reduce the fuel consumption of its aircraft. This technology, developed in collaboration with major players like JAXA and Nikon, is inspired by the hydrodynamics of sharks. Initial results are promising, with a significant reduction in air resistance.



Analysis of drag reduction effect estimation using riblets on an aircraft equivalent to the Boeing 787-9 (s+ distribution and surface rationalizations)

s+: dimensionless number used to evaluate the drag reduction rate of the riblet

Shark skin, a natural model of efficiency

Sharks owe their speed to their dermal denticles, tiny tooth-shaped scales. These structures create micro-vortices that reduce drag, allowing water to glide more easily.

The paint developed by Japan Airlines reproduces these patterns on a nanoscale. Applied to 30% of the surface of a Boeing 787-9, it has already shown a 5% reduction in friction resistance during tests.

Significant fuel savings

On a long-haul flight like Tokyo-Frankfurt, this innovation could save 119 tons of fuel per year per aircraft. This equates to a reduction of 381 tons of CO₂ emissions annually.

Japan Airlines is now monitoring the durability of this paint under extreme flight conditions, including temperature variations and pressurization cycles. If the results are conclusive, the treated surface could be expanded.

An alternative to adhesive films

Unlike "shark skin" films already tested by other airlines, this paint is applied directly to the existing coating. It does not add weight to the aircraft and eliminates the risk of peeling in flight.

This innovative approach could well establish itself as a sustainable solution to improve the energy efficiency of existing aircraft, without requiring major structural modifications.

To go further: What is drag?

Drag is an aerodynamic force that opposes the motion of an object, such as an airplane, in a fluid, such as air. It is caused by friction resistance and turbulence generated by the shape and surface of the moving object.

In the context of aviation, drag is a key factor influencing fuel consumption. The higher it is, the more energy the aircraft must expend to maintain its speed, which increases CO₂ emissions.

To reduce drag, engineers explore solutions like optimizing aircraft shapes or using special coatings. By minimizing drag, planes become more energy-efficient, reducing their environmental impact while improving overall performance.

Monday, Feb 17th 2025

The world's smallest business jet - worth £1.7million - is seen in the skies for first time (and Iron Maiden's frontman is keen to buy it)

- **The world's smallest business jet, Flaris LAR 1, is worth a whopping £1.7million**
- **Iron Maiden frontman Bruce Dickinson is reportedly keen to purchase it**
- **Reports say the plane only needs 100 metres of runway and is able to reach an altitude of 5,900 feet in a minute**

By ISABELLA NIKOLIC FOR MAILONLINE

PUBLISHED: 17:31 EST, 16 April 2019 | **UPDATED:** 03:23 EST, 17 April 2019

This is the moment the world's smallest business jet - which Iron Maiden frontman Bruce Dickinson is reportedly keen to buy - took to the skies for the first time in history.

Pilot Wieslaw Cena gave the mini plane, worth £1.7million, its first spin at the Zielona Gora Airport near the town of Babimost in Poland.

The five-seat Flaris LAR 1 is powered by a single Williams FJ33-5A turbofan engine and weighs only 700kgs.

World's smallest business jet takes to the skies for the first time.



+4

[View gallery](#)

The world's smallest business jet - which Iron Maiden frontman Bruce Dickinson is reportedly keen to buy - took to the skies for the first time in history



+4

[View gallery](#)

The five-seat Flaris LAR 1, worth £1.7million, is powered by a single Williams FJ33-5A turboprop engine and weighs only 700kgs

The aircraft also has detachable wings to help with storage.

Reports said that Mr Cena carried out 26 initial tests to check the plane's control and stability.

Footage shows the aircraft soaring through the sky before a very gentle touchdown on the runway.



+4

[View gallery](#)

The aircraft also has detachable wings to help with storage

Mr Cena is then seen getting out of the plane and laughing along with another man.

The pair then turn to the camera and give a thumbs up while smiling.

Rafal Landinski, the founder of the company Metal Master that designed the plane, said: 'The aircraft performed and handled very well in difficult conditions'.

Reports said that the plane only needs 100 metres of runway and is able to reach an altitude of 5,900 feet in a minute.

The company believes that the European Union Aviation Safety Agency (EASA) will green light the Flaris LAR 1 by the end of 2020.

British rocker Bruce Dickinson has reportedly expressed an interested in buying one of the jets.

The Iron Maiden lead singer is a keen pilot with over 10,000 flying hours under his belt and he even owns an aviation maintenance company.

Manufacturers believe that it will be the cheapest passenger jet on the market and have planned to produce several models next year.

World's smallest business jet worth £1.7million is seen in the skies for the first time

Newly Emerged Photos Show F-35C's Mirror-Like Coating with Damaged Tiles After Intensive Testing



The F-35C BuNo 168842 with the special coating parked at Midland airport, Texas, in November 2022. (Image credit: @TimHPatriot)

The photos, dated back to November 2022, show the second "chrome" F-35C with its peculiar mirror-like coating degraded over time during testing, before the aircraft was returned to its original livery.

Some previously unseen photos recently emerged online, showing one of the U.S. Navy's F-35Cs which received a [peculiar mirror-like coating](#). The photos, kindly shared with us by [@TimHPatriot](#), were captured at Midland airport, Texas, in November 2022 and show the F-35C BuNo 168842 parked on the ramp.

Notably, the tiles of the coating appear to be heavily degraded or corroded. According to the photographer, the pilot said the coating "were to help with the salty air on the skin, but the tiles kept peeling off in flight." If the pilot's

explanation was correct, this would be in contrast with one the most likely theory that was shared so far, the reduction of the infrared (IR) signature of the aircraft.

It would make sense for the tiles to peel off in flight if they were not just painted, but applied over the F-35's paint with an adhesive, similarly to [vinyl films](#) which are often used to temporarily apply special markings or liveries to aircraft. As for the salty air, another F-35C with a similar coating was tested aboard the USS Abraham Lincoln (CVN 72) aircraft carrier, while the one in the photo and another one were often spotted in the desert environments of Nellis AFB, Nevada, and Edwards AFB, California.

As we reported at the time, the first aircraft to be spotted with the new coating were F-22 Raptors. The F-22's delicate radar absorbent material (RAM), which requires extensive maintenance to avoid a quick deterioration, [was often seen heavily deteriorated](#), especially on non-combat coded aircraft used in training.

A U.S. Air Force 422nd Test and Evaluation Squadron's (TES) F-22 Raptor operational test pilot once mentioned in an interview that the coatings were experimental solutions which were being tested to see if they made it easier to maintain the sustainability and reliability of the aircraft.

This could have very well been the same reason behind the F-35C's new coatings, making more likely the explanation of the pilot of the aircraft in the latest photos. In fact, during the first operational deployments of the F-35C aboard aircraft carriers around the world, it has been noted that the RAM [showed significant wear and tear](#) in the demanding maritime environment, with what appeared to be rusty-looking deposit all across the aircraft.

F-35C BuNo 168842

The F-35C in these "new" photos had been already spotted at Edwards Air Force Base, California, in May 2024. In August 2024, newer photographs provided a better look at its peculiar coating while arriving at Naval Base Ventura County (NBVC) Point Mugu, California. The aircraft is assigned to the U.S. Navy's [Air Test and Evaluation Squadron Nine](#) (VX-9) out of Naval Air Weapons Station China Lake.



The F-35C XE-105 sporting the new coating. (Image credit: @point_mugu_skies)

The coating was applied to not interfere with access panels, weapon bays, sensor and antenna areas, landing gear doors and so on. Also, it appears that this coating was applied over the standard grey livery of the F-35C and they appearance changes depending on the angle on observation. The tiles have different dimensions and shapes, with some areas showing larger diamond-shaped tiles, while other area have smaller diamond or triangle-shaped tiles.

The F-35C XE-105 is only the latest of many aircraft to be seen with this new mirror-like coating, following two [F-22 Raptor](#) and a F-117 stealth fighters that have been spotted flying [since November 2021](#). The layout of the F-35's coating is similar to what was seen on the F-22, with what appear to be small, mirror-like tiles that have been extensively applied on the nose section, weapons bay doors, fuselage and also inner and outer face of the twin tails.

As for the F-22, the coating has been applied to not interfere with access panels, weapon bays, sensor and antenna areas, landing gear doors and so on. Also, it appears that this coating has been applied over the standard grey livery of the F-35C and they appearance changes depending on the angle on observation. The tiles have different dimensions and shapes, with some areas showing larger diamond-shaped tiles, while other area have smaller diamond or triangle-shaped tiles.



The Chrome Raptor about to land at Nellis AFB on Mar. 17, 2022. (Image credit: Steve Fortson)

Many theories emerged about the origin of these coatings, but without any official confirmation. The most credited ones were testing activities related to counter-IRST (InfraRed Search & Track) technologies or targeting systems, some kind of radar absorbent material (RAM) replacement or a passive laser defense system.

The photos captured at Midland airport might be the last of the aircraft before it was returned to its standard livery. In fact, the airframe 168842 was spotted in early 2023 with the usual grey livery, without the mirror-like coating. The F-35C later changed also its Modex from XE-105 to XE-101, but remained still assigned to VX-9.

It is unclear, however, which were the results of the testing and if it reached its objectives before the coating was removed.

Testing on the aircraft carrier

Another F-35C with a mirror-like coating, this time assigned to Strike Fighter Squadron (VFA) 125, was was photographed during a touch and go on Nov. 30, 2023, on [USS Abraham Lincoln \(CVN 72\)](#). The aircraft carrier was underway conducting routine operations in the Pacific Ocean, with the "Rough Raiders" of VFA-125, a Fleet Replacement Squadron from NAS Lemoore, California, embarked.



An F-35C Lightning II, assigned to Marine Strike Fighter Squadron (VFA) 125, prepares to make an arrested landing on the flight deck aboard the Nimitz-class aircraft carrier USS Abraham Lincoln (CVN 72). (U.S. Navy photo by Mass Communication Specialist Seaman Sonny Escalante)

This was the first time, at least to our knowledge, that this exotic scheme of the F-35 was spotted in a carrier environment. This time, however, the coating was not applied extensively as in the other cases, but can be seen only on both sides of the vertical tails and wings, while the fuselage has the standard F-35 coating.

The "[chrome](#)" coating alternated dark and shiny patches, making up three larger stripes of different colors. While it was unknown why the new coatings are [being used by a FRS](#) on an aircraft carrier, a plausible hypothesis we posited was a test in the harsh maritime environment with aircraft subject to a high volume of flight activity.

SR-72: The U.S. Air Force's 'New Hypersonic Bomber' Could Be Real



SR-72

What You Need to Know: The SR-72, developed by Lockheed Martin's Skunk Works, is a proposed hypersonic reconnaissance aircraft aimed to fill critical intelligence gaps in the U.S. Air Force. Expected to fly in the mid-2020s, it may reach Mach 6 (4,100), surpassing all previous aircraft speeds.



SR-72© Provided by National Interest

-Unlike the SR-71 Blackbird, the SR-72 could be armed with hypersonic munitions to increase versatility and offset high costs. As reconnaissance needs evolve with advanced satellites, the SR-72's speed and optional pilot feature could offer unmatched rapid response.

-However, it faces potential threats from advanced directed-energy and hypersonic weapons, demanding new countermeasures.

SR-72 Hypersonic Aircraft: Revolutionizing High-Speed Reconnaissance

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Unlike the SR-71 Blackbird, the SR-72 is likely to be armed with hypersonic munitions to increase versatility and offset high costs.

As reconnaissance needs evolve with advanced satellites, the SR-72's speed and optional pilot feature could offer unmatched rapid response.

However, it faces potential threats from advanced directed-energy and hypersonic weapons, demanding new countermeasures.

The SR-72 is the potential answer to a current capability gap in the U.S. Air Force.

Envisioned as a hypersonic, high-altitude reconnaissance aircraft, the SR-72 promises to do a lot. What Lockheed Martin's futuristic aircraft will deliver and if the Pentagon will buy it remain to be seen.



SR-72© Provided by National Interest

SR-72: An Ambitious Aircraft

Developed by Lockheed Martin's famous Advanced Development Programs, also known as "Skunk Works," the SR-72 is a [hypersonic demonstrator aircraft](#) that will first fly sometime in the mid-2020s.

Reportedly designed as an optionally manned aircraft, meaning that it can have a human pilot on board, but it is not required to fly, the SR-72 promises to revolutionize aviation.

Reports [indicate](#) that the SR-72 might have a speed of Mach 6. No other aircraft in [aviation history](#)—spaceships not included—has even approached such speeds.

Mach 6 translates into more than 4,100 miles per hour.

When the SR-71 Blackbird ruled the skies, the U.S. and its adversaries lacked advanced spy satellites that could take timely and accurate pictures. Today, however, that is no longer the case. Both the U.S. and its adversaries possess highly advanced spy satellites that can provide a detailed picture of an enemy's order of battle. If that wasn't enough, commercial satellites that are accessible to the public have democratized imagery collection—although not analysis.

What that means for the SR-72 is that Lockheed Martin and the Air Force are highly likely to arm the aircraft in order to make it more versatile and justify its expected high cost. And the most logical choice for a Mach 6 aircraft is [hypersonic munitions](#).



SR-72© Provided by National Interest

“We’ve been saying hypersonics is two years away for the last 20 years, but all I can say is the technology is mature and we, along with DARPA [Defense Advanced Research Projects Agency] and the services, are working hard to get that capability into the hands of our warfighters as soon as possible,” Rob Weiss,

Lockheed Martin's executive vice president and general manager for Advanced Development Programs, [had told](#) Aviation Week about the development of the SR-72 in 2017.

The SR-72 Has Big Shoes to Fill

The SR-72 is the direct descendant of the legendary SR-71 Blackbird and is closely related—in terms of mission sets—to the venerable U-2 Dragon Lady.

As a result, it has some very big shoes indeed to fill. For example, the U-2 arguably was key in preventing World War Three from starting.

In October 1962, the Russians had placed nuclear missiles in Cuba only a few hundred miles from the shores of the U.S. High-altitude flights from the U-2 [revealed the presence of the Russian nukes](#) and informed the decision of President John F. Kennedy to confront the Soviet Union's leadership.

If it wasn't for the reconnaissance aircraft and the highly skilled analyst of the U.S. Intelligence Community, the U.S. political and military leadership would have been at a disadvantage vis a vis their Soviet counterparts.

The Cuban Missile Crisis is one of the few instances when the stealthy U-2 publicly showed its value and the benefit of a robust intelligence, surveillance, and reconnaissance fleet. Once the SR-71 Blackbird took to the skies in the mid-1960s, it continued to show the value of such aircraft, conducting highly dangerous missions over Soviet airspace, and taking pictures of Soviet nuclear missile sites and military bases.

Flying at between 80,000 and 85,000 feet—an impressive 50,000 feet higher than commercial airliners, the SR-71 Blackbird was simply untouchable by enemy anti-aircraft weapon systems. To fly at such high altitudes, closer to space than to the Earth, [SR-71 Blackbird](#) pilots had to wear spacesuits.

By the time the SR-71 Blackbird retired in 1998, an astounding 4,000 air-to-air and ground-to-air missiles had been fired at it in an attempt to shoot it down. The spy aircraft, however, was simply too fast for them.

If the SR-72 program does produce an operational aircraft, it will be facing different challenges, ranging from directed-energy weapons, such as [lasers](#), and hypersonic munitions. And so, it will require new countermeasures.

DELOREAN 'FLYING CAR' IS NOT THE DELOREAN YOU HAVE COME TO EXPECT

DELOREAN 'FLYING CAR' IS NOT THE DELOREAN YOU HAVE COME TO EXPECT



DeLorean did not promise us flying cars, but *Back to the Future II* sure planted that idea into our heads. Since then, companies and individuals have not stopped trying to make the car fly, which now apparently includes the DeLorean. Wait, what? A *flying* DeLorean? A very interesting prospect that piqued a BTTF fan like me. But unfortunately, it won't be the DeLorean DMC-12 that will fly. In fact, John DeLorean, the person responsible for the made-famous-by-movie iconic ride, is not behind this ambitious endeavor. Instead, it is Paul

DeLorean, the legend's nephew, and his startup DeLorean Aerospace, who will be making a flying DeLorean a reality.



And really, no, no flying DMC-12 and certainly, there won't be one that time travels. So, don't expect a chunk of Mr. Fusion-powered brushed stainless car zipping across the skies. It will be more like a light aircraft which the young company christens [DR-7 VTOL](#). So, yeah, it is a vertical take-off and landing vehicle after all. No witchery or anything magical here. In other words, it is far from our sci-fi movies-driven fantasy, but I supposed it will do as long it can actually function like a car, or at least, fits into a garage and also, it should never need a runway.



What DeLorean Aerospace is embarking on is not unlike some concepts, but it does have a rather compelling pitch that describes the DR-1 as “built like an F1 race car,” but destined for the sky. Ok. So, it is a sports aircraft, I get it, but with VTOL capability. Anywho, the DR-1 will feature a monocoque composite body and a high-efficiency wing design to realize both speed and maneuverability. Like some of the flying cars in development, it will have hinged wings that are designed to be easily stowed away so it could be parked in your home garage. Plus, it will be electrically driven with an audacious goal of making 120 miles (approximately 193 km) on a single charge.

Considering that most electric-powered “flying cars” or personal light aircraft only tout 25-50 miles (or about 40-80 km). How exactly that will pan out, remains to be seen. At this point, it is all about development and we will be eagerly anticipating its arrival (not that anyone of us will be able to buy one...). That being said, there is really as much information as you have read here, so far, which makes the anticipation even more exciting. I, for one, will be keeping my eyes peeled on its development cos’, after all, it will be the first real flying DeLorean.

Images: [DeLorean Aerospace](#) via [Wired](#).

US Air Force's 6th-gen fighter NGAD hits milestone with engine design success



US Air Force's 6th-gen fighter NGAD hits milestone with engine design success

The U.S. Air Force's sixth-generation fighter is one step closer to reality, as two proposed engines intended to power the aircraft have successfully passed a significant design review.

This milestone was recently announced by the defense firms involved in the development process.

General Electric Aerospace and Pratt & Whitney have completed detailed design reviews for their respective engines, referred to as XA102 and XA103.

This success allows the companies to move on to the next stage: developing prototype demonstration engines.

Engine design success

These engines are significant components of the Air Force's Next Generation Adaptive Propulsion (NGAP) program, which aims to provide the propulsion system for crewed fighters within the Next Generation Air Dominance (NGAD) initiative.

The engines feature adaptive technologies that enable aircraft to adjust their thrust configurations based on specific flight situations, offering range, and thermal management advantages compared to conventional engines.

Although adaptive technology was considered for the F-35 Joint Strike Fighter, the Pentagon ultimately opted to enhance the existing F-35 engines due to concerns over costs and compatibility across various F-35 models.

Both companies released statements emphasizing the innovative digital design techniques they employed during their review processes.

Pratt & Whitney, a subsidiary of RTX, highlighted how its “collaborative digital environment” streamlined the engine design process.

This approach facilitated the electronic transmission of necessary data to reviewers, allowing for more efficient verification of the plans for the XA103 engine.

Jill Albertelli, the president of military engines for Pratt & Whitney, noted the importance of this first fully digital review in delivering advanced capabilities to warfighters.

Meanwhile, GE Aerospace praised the application of model-based systems engineering in designing the XA102 engine, calling it a transformative shift in the approach to advanced propulsion system testing and development.

Steve Russell, who leads GE Aerospace’s Edison Works division, expressed optimism about incorporating this innovative engineering approach as they move forward into the next phases of procurement and production.

U.S. Air Force’s 6th-gen fighter NGAD

In January, the Air Force announced contract modifications for both firms, increasing the ceiling for the prototype phase of the NGAP contracts to \$3.5 billion each.

This new figure represents more than triple the original contract value of \$975 million awarded to both firms in 2022.

With the design reviews now completed, the companies are beginning to acquire the hardware required for constructing their engines, with Pratt & Whitney anticipating that testing of its prototype will occur by the end of the decade.

However, questions remain about the future of the NGAD fighter [program](#) itself, especially after the Air Force placed the initiative on hold last summer due to escalating cost estimates.

This move initiated a review of alternative strategies to ensure air dominance at a reduced expense.

After the upcoming 2024 presidential election, then-Air Force Secretary Frank Kendall decided to defer the decision regarding NGAD to the incoming administration.

However, studies conducted by the Air Force have indicated a clear need for such a program.

Additionally, the U.S. Navy recently awarded Pratt & Whitney a contract worth \$186 million to support the sustainment of the F-35's F135 engines.

This contract includes funding for materials and support for maintenance facilities.

Furthermore, Pratt & Whitney secured a substantial three-year, \$1.5 billion contract in December to maintain the XA103 engines used in Air Force F-22 Raptors to enhance operational readiness and reduce costs [associated](#) with over 400 engines.

As defense firms continue to develop their engines and the Air Force reassesses its acquisition strategies, the path to realizing the NGAD fighter remains uncertain but is closely monitored by industry and military leaders.

The “NGAD” Sixth-Gen Fighter Just Passed A Key Test



The “NGAD” Sixth-Gen Fighter Just Passed A Key Test

As a “family of systems,” NGAD is expected to include a manned sixth-generation stealth fighter and a mass of Collaborative Combat Aircraft (CCAs) that will serve the jets as loyal drone wingmen.

The Air Force’s Next-Generation Air Dominance (NGAD) program may be waiting for the stamp of approval from President Donald Trump’s new appointees, but the futuristic aircraft continues to reach new milestones. This week, proposed engines from two major manufacturers [passed](#) a significant design review. GE Aerospace and RTX’s Pratt & Whitney are both moving forward to construct engine prototype demonstrations after finalizing their respective design reviews for the Next-Generation Adaptive Propulsion program. The winner of NGAP will

see its engines become the power source for the service's sixth-generation fighter project.

In a press release, GE [noted](#) that the completion of design review "marks a significant step toward delivering revolutionary propulsion technology for the Air Force's future fleet," adding that in its design presentation to the service it displayed "the comprehensive digital engine model and [validated] its readiness for the next stage of development." According to Air and Space Forces, GE's XA102 engine prototype was the first in the company's history to be designed via a model-based systems engineering approach. Pratt & Whitney executives mirrored this rhetoric, asserting that digital processes would be at the foundation of its "technology maturation for future next-gen solutions."

Last month, the service announced it would be greatly [expanding](#) funding for the prototype engine for the NGAD program. At this time, both Pratt & Whitney and General Electric received alterations to their initial Next Generation Adaptive Propulsion (NGAP) contracts that increased their respective budgets nearly threefold. As [detailed](#) by the Pentagon, "The work includes design, analysis, rig testing, prototype engine build and testing, and weapon system integration. The contract modification is for the execution of the prototype phase of the Next Generation Adaptive Propulsion program and is focused on delivering a state-of-the-art propulsion system with a flexible architecture that can be tailored for future combat aircraft operating across various mission threads; and digitally transforming the propulsion industrial base."

A Brief Overview of NGAD

Progress on NGAD's engine development is a huge [milestone](#) for the service, which hopes to introduce its sixth-generation fighter as a means to counter the growing threat from China's aerial capabilities. NGAD is derived from the Air Force's Aerospace Innovation Initiative, which aimed to develop prototypes for future aircraft by incorporating the Defense Advanced Research Agency's (DARPA) Air Dominance study. As a "family of systems," [NGAD](#) is expected to include a manned sixth-generation stealth fighter and a mass of Collaborative Combat Aircraft (CCAs) that will serve the jets as loyal drone wingmen. The inclusion of drones in the NGAD proposal is designed to lower the overall cost of the project.

The Air Force's decision to boost the budgets for [NGAD's engines](#) follows the service's budget increase for its existing F-22 Raptor fleet. Pratt & Whitney was awarded a \$1.5 billion contract in December to sustain the F119 engines that power these fifth-generation jets. While budgetary constraints may be of concern, the Air Force is still prioritizing the maintenance and further development of its top-tier fighter platforms.

How Would Hypersonic Scramjets Work?



Supersonic combustion is used to propel hypersonic scramjets, which travel at speeds over Mach 5. These engines are fundamentally different from traditional jet engines. They feature a more efficient, streamlined design that eliminates reliance on rotating parts like compressors and turbines. Compressed by the vehicle's forward motion, the incoming air is then combined with fuel and ignited in supersonic conditions. This makes it possible for scramjets to operate at the highest efficiency while flying at very high speeds.

Photo: US Air Force

The Boeing X-51 Waverider demonstrated the viability of scramjet technology during a 2013 test flight, reaching Mach 5.1 while flying for over three minutes, as reported in Boeing's official [media release](#). The applications that use this exotic and powerful engine range from space exploration to advanced missile systems or ultra-rapid intercontinental travel, hypersonic propulsion has a vast potential for both military and commercial aerospace.

The Boeing X-51 Waverider was carried to altitude by a B-52 Stratofortress for its historic test flight.

Design principles of scramjet engines

Eliminating moving parts, hypersonic scramjets compress incoming air by using the already high-speed airflow available. The process of generating the required pressure increase for combustion depends on the vehicle's speed being high at the beginning of the cycle. The engine's design uses a thrust-producing nozzle, a combustion chamber shaped for supersonic airflow, and a streamlined inlet. In contrast to their ramjet predecessors, scramjet engines continue to produce supersonic airflow for the duration of the engine cycle. The design removes any requirement for subsonic diffusion, which is necessary for effective combustion in ramjets. As NASA explains on their [educational webpage](#), scramjets achieve higher operational speeds by eliminating the deceleration of airflow to subsonic levels, a fundamental limitation in ramjets.

Engine construction is made simpler and lighter by the lack of moving parts, but aerodynamic and thermodynamic design accuracy is crucial. With the nozzle supplying propulsion and the inlet compressing the air, the vehicle structure itself functions as an integral component of the engine. Because of the combination of high-speed air friction and combustion temperatures, materials used in scramjets must be able to withstand extremely high temperatures. One of the main engineering challenges is still creating components and materials that can survive in this environment. The development efforts are ongoing, but as always, funding allocation is a contest that can prolong the time before results are achieved.

Applications in aerospace

Applications requiring sustained hypersonic speeds, like space exploration, advanced Military systems, and extremely quick commercial transportation, could be revolutionized by scramjets. The successful testing of the Boeing X-51 Waverider demonstrated the potential for incorporating scramjet propulsion into high-speed vehicles. The foundation for succeeding progress with this technology was laid by the X-51 program's demonstration of hypersonic flight. A [photo essay from the US Department of Defense](#) describes how hypersonic systems powered by scramjets are being explored for military purposes, such as missile systems capable of traveling at speeds too fast for conventional defense mechanisms to intercept.

By lowering the cost of launch into orbit, scramjets have the potential to transform space travel beyond military uses. Engineers hope to replace conventional rocket boosters using heavy, expensive chemical fuels by incorporating scramjets into the early stages of space launch vehicles. Efficiently accelerating to orbital speeds inside Earth's atmosphere may reduce obstacles to space travel, allowing for deeper space exploration missions and quicker and less expensive satellite deployment. Another promising area is hypersonic cargo transport, which could deliver payloads worldwide in a fraction of the time traditional air transport currently takes. Just think, you could order a handmade scarf from Switzerland and deliver it to California the same day. It's hard to say what the shipping fees might be, though!

Challenges in scramjet development

There is a lot of promising potential. However, scramjet technology has a lot of obstacles to overcome before an operational aircraft or spacecraft rolls onto the tarmac. The brutally harsh circumstances of hypersonic flight present a number of engineering challenges in reference to stable combustion, heat management, and material durability. Research into innovative new materials that can withstand such thermal stress is necessary because heat from just the air friction can reach thousands of degrees Celsius while flying at speeds above Mach 5. Additionally, scramjets require precise ignition and fuel injection systems that can function dependably in the extremely harsh, compressed, and turbulent airflow that characterizes supersonic combustion.

Creating next-generation scramjet engines requires a focus on designs that sustain efficient and controlled combustion at hypersonic speeds. Northrop Grumman is aggressively tackling these issues in their research efforts. Their work aims to improve scramjet engine construction's structural and operational resilience under extreme conditions, as outlined in their [technical overview](#), which is available online. This calls for progress in experimental testing as well as computational modeling. The viability of broad scramjet adoption in aerospace will depend on how well these technical obstacles are resolved and how quickly they are resolved.

X-51A Waverider: What To Know About Boeing's Experimental Scramjet For The US Air Force

The X-51A Waverider is a groundbreaking hypersonic aircraft pushing the limits of speed and technology redefining the future of flight.

A promising experiment that holds the potential for a major advancement in propulsion technology, scramjets provide unmatched speed and efficiency for various aerospace applications. The Boeing X-51 Waverider's success demonstrates the advancements made in the field to date and confirms that sustained hypersonic flight is feasible. Future developments in material science, aerodynamics, and thermodynamics will be essential to overcome the obstacles preventing scramjet development. A new era of aerospace innovation could be ushered in by fully utilizing this technology, which has the potential to revolutionize defense, space exploration, and international transportation.

X-51A Waverider: What To Know About Boeing's Experimental Scramjet For The US Air Force



Photo: USAF | Simple Flying

The X-51A Waverider represents a revolutionary leap in aerospace **technology**, designed to achieve sustained hypersonic flight. Developed by the **US Air Force** and **Boeing**, this unmanned scramjet aircraft has the potential to travel at speeds exceeding Mach 5, harnessing advanced propulsion systems that utilize air-breathing engines. With its ability to glide at extreme velocities, the X-51A paves the way for future military and civilian applications, from rapid global travel to enhanced missile capabilities. Its successful flight tests mark significant milestones in aerodynamics and **engineering**, showcasing a new era of speed and efficiency in aviation. As the quest for faster and more efficient aircraft continues, the Waverider stands at the forefront, pushing the boundaries of what is possible and inspiring **innovations** that could transform air travel. The X-51A is a glimpse into the future of hypersonic flight.



Photo: US Air Force

Bleeding Edge

The X-51 was engineered as a **missile** -sized test aircraft to demonstrate scramjet operation within the speed range of Mach 4.5 to Mach 6. The SED-WR program finished its preliminary **design** review (PDR) in December 2004, and a contract for the detailed design phase of the **X-51** was awarded in January 2005, with the critical design review (CDR) completed in January 2007. The lifting body design allows the vehicle to generate significant lift during flight without relying solely on **wings** . Weighing approximately 1,814 kg, the aircraft can be fully controlled at **supersonic** speeds, even when gliding without propulsion. At high speeds, excessive heat can potentially damage the metal components of the airframe by melting them. To prevent this, **hypersonic** combustion creates cooling water cycling behind the engine cowl and along the sidewalls, keeping the surfaces at a safe operating temperature.

The X-51 is powered by the Pratt & Whitney Rocketdyne SJY61-2 scramjet engine, which uses hydrocarbon JP-7 fuel. Conventional turbine engines are employed for high-speed research at supersonic levels. Upon ignition, a mixture of ethylene and JP-7 is initially burned before switching exclusively to JP-7 fuel.



Pushing the Limit

In the 1990s, the Air Force Research Laboratory (AFRL) initiated the HyTECH program focused on hypersonic propulsion. **Pratt & Whitney** was contracted by the AFRL to create a hydrocarbon-fueled scramjet engine, resulting in the development of the SJX61 engine. Initially intended for the now-canceled **NASA** X-43C, the SJX61 was later incorporated into the AFRL's Scramjet **Engine** Demonstrator program in late 2003.

"This first flight was the culmination of a six-year effort by a small, but very talented AFRL, DARPA, and industry development team," Mr. Brink said [after

the X-51's first [captive carry mission](#) on December 9, 2009]. "Now we will go back and really scrutinize our data. No test is perfect, and I'm sure we will find anomalies that we will need to address before the next flight. But anyone will tell you that we learn just as much, if not more, when we encounter a glitch."

To achieve flight, the [X-51](#) is transported by a [B-52](#) to around 50,000 feet (15 km) before being released over the Pacific Ocean. The X-51 is first propelled by an MGM-140 ATACMS solid rocket booster, which launches it at speeds of approximately Mach 4.5 (3,000 mph; 4,800 km/h). After the booster expends all its fuel, it is jettisoned then the Pratt & Whitney Rocketdyne SJY61 scramjet accelerates to nearly Mach 6 (4,000 mph; 6,400 km/h)

The scramjet flight test vehicle was officially designated X-51 on September 27, 2005.

Streaking through Skies

On [May 1, 2013](#), the U.S. military conducted the final test flight of a hypersonic aircraft, propelling it to over five times the speed of sound in the longest mission of its kind.

"It was a full mission success." — Charlie Brink, X-51A program manager for the Air Force Research Laboratory Aerospace Systems Directorate.

The Air Force's [X-51A Waverider](#) achieved a maximum speed of Mach 5.1 during this test, covering more than 230 nautical miles in just over six minutes before crashing into the Pacific Ocean off the [California](#) coast, as planned. This flight was the last of four X-51A vehicles developed by Boeing for Air Force experiments following a previous test failure in August 2012. This mission marked the longest air-breathing hypersonic flight to date. The X-51A took off Wednesday morning from Edwards Air Force Base in California, carried by a B-52H Stratofortress. Released at about 50,000 feet (15,000 meters), the Waverider used a solid [rocket](#) booster to reach Mach 4.8 in just 26 seconds. After separating from the rocket, it accelerated to Mach 5.1 at an altitude of

60,000 feet (18,300 meters), powered by its air-breathing supersonic combustion ramjet (scramjet) engine.

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The X-51 uses **JP-7** fuel for the SJY61 scramjet, carrying 270 lb (120 kg) on board.

X-51A Waverider Key Specifications

- Primary Function: Hypersonic scramjet-powered flight test demonstrator
- Contractors: Boeing, Pratt & Whitney Rocketdyne
- Power Plant: JP-7 fueled/cooled SJY61 supersonic combustion ramjet
- Thrust: 500–1,000 pound class
- Length: Full stack 25 feet; Cruiser 14 feet; Interstage 5 feet; Solid rocket booster 6 feet
- Weight: Approx. 4,000 pounds
- Fuel Capacity: Approx. 270 pounds JP-7
- Speed: 3,600+ miles per hour (at Mach 6)
- Range: 400+ nautical miles
- Ceiling: 70,000 + feet
- Crew: ground station monitored
- Unit Cost: Unavailable
- Initial Flight Test: May 26, 2010
- Inventory: Four purpose-built for flight test, not designed for recovery (one vehicle expended as of Feb. 1, 2011)

5 Aircraft Used In The North American X-15 Hypersonic Program

Two of these aircraft are bombers, while the remaining three set the glorious records associated with the X-15.

We Got Up Close with Sikorsky's S-97 Raider

The Aviationist was among the outlets invited to attend a demonstration event of the X2 technology at the Sikorsky Development Flight Center. Here's how it went.

After the U.S. Army's [FARA program was cancelled in 2024](#), Sikorsky has continued to work on its S-97 Raider demonstrator. As the Raider's underlying X2 technology is now being proposed to NATO and South Korea for their Future Vertical Lift programs, on Feb. 11, 2025, *The Aviationist* was among the outlets who were invited to the Sikorsky Development Flight Center to attend a demonstration of the X2 technology.

The event included two days of activities, with the first one focused on a walkaround of the S-97, a simulator session and briefings about the X2 technology, while the second day was focused on the flight demonstration itself. Program officials, engineers and test pilots were all on hand to answer to questions and provide additional info.

Without further ado, let's now delve into the details about the X2 technology and the S-97 Raider. This report will be divided into a four-part series, with the second one focusing on the walkaround of the Raider and the flight demonstration.

The X2 technology

The [S-97 Raider](#) which Sikorsky displayed at its Development Flight Center in West Palm Beach, Florida, is the result of 20 years of development, started in 2005 with the X2 demonstrator. That demonstrator flew from 2008 to 2011 and reached a speed of 252 kts in level flight, way higher than a normal helicopter.

In fact, the X2 was not a standard helicopter, but a compound helicopter, with two coaxial counter-rotating main rotors and a prop rotor in the tail. This solution exploited the Advancing Blade Concept that Sikorsky developed in the 1970s, however at the time there were still some technical challenges to solve, and that took decades.

Sikorsky created the Advancing Blade Concept with the goal of significantly increasing helicopter flight speed. The concept is based on the rotor's ability to develop lift on the blade that advances in the direction of flight, relieving of this duty the retreating blade that goes in the opposite direction. Using counter-rotating, rigid rotors with limited bending in the vertical direction, this design delayed the drag increase caused by the blades' tip Mach number effects, thus enabling higher speeds.

The concept was first tested in [NASA's](#) wind tunnel and led to the S-69 (also known as XH-59A) demonstrator, which reached 240 knots in level flight and 263 knots in a shallow dive with two auxiliary jet engines mounted on the sides. The demonstrator improved speed, altitude, and control without compromising hover efficiency, however, it had drawbacks such as heavy titanium rotors, high fuel consumption, rotor drag, heavy pilot workload and vibrations.

The technological limitations prevented further development at the time. Technology evolved through the years and, decades later, advancements such as composites rotor blades and fly by wire control system, together with a pusher propeller added for efficiency, solved some of the technical challenges, paving the way for the [X2 technology](#) demonstrator which proved out the efficiency and the viability of this technology.

Sikorsky viewed this technology as the perfect choice for the [U.S. Army's](#) armed aerial scout which was supposed to replace the OH-58 Kiowa Warrior, the Future Attack Reconnaissance Aircraft (FARA) program, which was canceled in 2024. The program resulted in a new demonstrator, the S-97 Raider, on which the company applied all the lessons from the past and is continuing to learn new ones, as the team is completing engineering experiments on the aircraft on a regular basis to advance and mature the technology for the future.

The FARA program

The Future Attack Reconnaissance Aircraft program was launched in 2018 to develop a successor to the [Bell OH-58D Kiowa Warrior](#) scout helicopter, retired in 2014, as part of the Future Vertical Lift program. This was the fourth time the service tried to replace the OH-58, and the service was also looking to replace nearly half of the AH-64 Apache fleet with the new FARA.

The U.S. Army aimed to field the new aircraft by 2028. In April 2019, design contracts were awarded to five manufacturers, which were to present their design by February 2020.

According to the mandatory requirements, FARA candidates were required to use the General Electric T901 engine, selected under the [Improved Turbine Engine Program \(ITEP\)](#), and the General Dynamics XM915 20mm cannon. The maximum dimensions were to not exceed 40 foot (12 m) for both rotor diameter and fuselage width, with an unspecified target gross weight and payload and an affordability goal.

The aircraft was supposed to meet a minimum speed of 180 knots and a maximum speed of 205 knots, range of 135 nm, 90-minute on station endurance, 4000 feet/95 F Hover Out of Ground Effect (HOGE). Another requirement was a pilot-optional capability that could be further exploited in future and a Modern Open Systems Architecture (MOSA) to be able to easily upgrade the aircraft.

After that 2020 deadline, the Bell 360 Invictus and the Sikorsky Raider X were selected for the second phase of the FARA program. The two companies received contracts for detailed design, build and test of their air vehicle solutions and were expected to face a final fly-off competition in 2023, later delayed to 2024.

However, in 2024, the U.S. Army has unexpectedly announced the cancellation of the FARA, in an abrupt change of its plans for the 2030s' Army aviation. The service said this was based on lessons learned and a sober assessment of the modern battlefield, which led to the decision to invest in unmanned assets.

This way, the Invictus and the Raider X suffered the same fate of the other helicopters that were supposed to replace the OH-58 in the last two decades, the [RAH-66 Comanche](#) and the ARH-70 Arapaho.



The S-97 Raider

The day before the flight demonstration, we had a chance to do a complete walkaround of the first [S-97 Raider](#) built, which flew for the first time in May 2015 and is now used as a static display. Sikorsky's experimental pilot Bill Fell provided many insights in the design and characteristics of the Raider

"It's a spectacular aircraft, it is absolutely the sports car of helicopters, and it's really a pleasure to fly," Fell enthusiastically told us while describing his experience flying the Raider.

The rotor system is a critical element of the S97's design, "some of the bread and butter" of the Advancing Blade Concept, as Fell described it. Unlike traditional helicopters, the X2 employs rigid rotors with an effective hinge offset significantly higher than conventional designs. This rigid rotor also has 50% less parts than an articulated rotor.

Whereas helicopters like the [UH-60 Black Hawk](#) have a hinge offset (the distance between the flapping hinge and the rotor mast, used as a measure of the rigidity of the rotor) of 12-18%, the X2 boasts a figure exceeding 40%, potentially

reaching 45%. This increased rigidity enhances control power and reduces response time, allowing for precise maneuverability.



The S-97 Raider and, in the background, an MH-60R Seahawk, providing a quick comparison between the two main rotor technologies.

In conventional single-main-rotor helicopters, as speed increases beyond 150 knots, the retreating blade encounters aerodynamic limitations, experiencing reversed airflow (as the blade retreats, the airflow moves from the trailing edge to the leading edge, lowering the relative speed) and eventually suffering from [retreating blade stall](#), one of the most hazardous flight conditions in helicopters where the blade doesn't produce lift anymore.

This phenomenon imposes a speed constraint on traditional rotorcraft, as the issues on the retreating blade would cause an unbalanced lift distribution on the rotor. However, the X2's coaxial rotor configuration mitigates this issue by utilizing the advancing blades on both rotors to maintain balanced lift distribution, effectively eliminating retreating blade stall as a limiting factor.

Normally, the two rotors move in unison and when the pilot pushes the stick forward, both rotors tilt accordingly. However, there are situations where

independent movement is necessary. The flight control system (FCS) manages these adjustments while maintaining a consistent 30-inch tip separation. The rotors are designed to allow up to 20 inches of coning for maneuverability, but a third of the tip separation (10 inches) is reserved as a safety margin, ensuring the blades never come too close to one another.



The two main rotors' heads and the fairing covering the rotor mast.

Unlike conventional helicopters, which require a tail rotor to counteract torque effects, the X2 balances the torque between its two main rotors. In low-speed environments, differential pitch between the rotors enables yaw control, while at higher speeds, rudders take over to ensure coordinated turns. The [fly-by-wire system](#) automatically transitions between these control mechanisms, ensuring smooth handling without requiring additional pilot input.

The main gearbox plays a crucial role in transferring power efficiently between components. The lower rotor functions similarly to a conventional main rotor, with three hydraulic servos transmitting inputs via a swashplate mechanism to change the blades' pitch. The upper rotor mirrors this setup but in an inverted

configuration, utilizing pitch change rods that pass through the gearbox to deliver control inputs.

The swashplate for the upper rotor is located below the gearbox, while the swashplate for the lower rotor is located above the gearbox. The gearbox has a compact design and is fed by a single driveshaft. Additionally, aerodynamic efficiency is further enhanced by the streamlined fairing between the rotors, reducing drag.

Since the counter-rotating rotors cancel out torque effects, instead of a tail rotor, the S-97 features a pusher propeller that provides forward thrust. This is a critical component of the S-97's high speed capability, which allowed the aircraft to reach 207 kts in level flight, while without the prop the S-97 "only" reaches 150 kts.

The [pusher propeller](#) is engaged via a clutch system and can be disengaged entirely, although when disengaged it still turns like a freewheel at 200 RPM to prevent damage to its composite blades, since the prop sits just behind the engine exhaust. The normal speed is around 2,000 RPM.

In conventional helicopters, a tail rotor typically consumes about 1/9th of the total power. In the S-97, more power can be allocated to the pusher propeller than to both main rotors combined, depending on the requirements and the situation. The aircraft's flight control system (FCS) prioritizes rotor operation, as the main rotors are essential for maintaining lift, avoiding the risk of selecting too much power for the prop. The FCS looks primarily at two limitations, the available power and the torque limits.



The tail of the S-97, prominently showing the pusher propeller, the elevators and rudders.

The system allows for variable thrust output, including a significant negative pitch range, which can act as an airbrake. A switch on the collective allows the pilot to select the required power output. The acoustic signature of the S-97 changes fairly significantly with the prop, and this is also one of the considerations made to determine when to use it.

When the propeller is active, the aircraft exhibits different handling characteristics. During takeoff, the propeller can be used to assist in acceleration. Pushing the nose forward, similar to traditional helicopter flight, is initially more efficient as the main rotor gets "a much bigger bite of the air," but as the propeller's airflow efficiency increases with the speed, it functions almost like a turbo boost, enhancing acceleration.

The negative range of the prop allows multiple uses to increase the capabilities of the S-97. "I honestly think the negative range is of the best capabilities of that prop," said Fell during the walkaround. As an example, during an aggressive [assault landing](#) where the helicopter approaches the landing zone at high speed, putting negative pitch on the prop allows to quickly decelerate without having to bring the nose up too much, which would cause a loss of situational awareness and visibility in one of the most delicate phases of the flight.

If the propeller is set to maximum deceleration capability when in a hover, the aircraft will rapidly begin moving backward. To counteract this, the pilot can engage a neutral setting, known as the zero-thrust button, effectively eliminating any thrust or drag from the prop.

The negative pitch in the hover, however, is not an undesirable setting, as it can be used to either fly backwards or balance the helicopter to hover with the nose down. Similarly, positive pitch enables to hover with the nose up. Tests have demonstrated the ability to maintain a nose-down pitch of 7-8° and a nose-up pitch of 20° during hover with the help of the prop. The ability to maintain these different attitudes in hover is particularly beneficial for armed aircraft, eliminating the need for articulated pylons to employ weapons, like the ones used by the [AH-64 Apache](#).

The rudders and elevators are electrically actuated. The rudders, which are positioned further away from the tail boom compared to traditional designs, play a critical role in turn coordination, especially at high speed. The cabin of the S-97 can accommodate up to six passengers, making it adaptable for multiple mission profiles, including attack and troop transport roles.



The cabin of the S-97 Raider.

The cockpit of the X2 is not as spacious as the one of a UH-60, with Fell describing it saying "it's a fairly tight cockpit, but that's the sportscar nature of this machine." The doors are small, as it was decided as a safety measure to only have a smaller upper section of the door that could be opened.

The cockpit features sidearm controllers with a small, half inch, input range, enabling precise adjustments, with a single collective between the seats. Most of the time, the fly by wire system doesn't require the pilot to hold the controls, as it is a full-authority system that requires only the necessary inputs to maintain control. Additionally, a tiered flight control system and attitude command modes for various flight conditions help reduce the pilots' workload.

A difference that immediately catches the eye is the missing multitude of circuit breakers. Instead, the S-97 uses solid-state power controllers, which can be controlled through the cockpit displays, with just two traditional circuit breakers for redundancy on critical systems. Any issues are flagged on the displays, which provide alerts as needed.

Another advanced technology present of the S-97 is the smart pitot tubes. Unlike traditional systems that rely on pneumatic lines to measure airspeed through pitot tubes and static ports, these are solid-state probes that send electrical signals. This design eliminates the need for pneumatic systems, allowing for quicker replacement if something malfunctions.



The cockpit of the S-97 Raider, with the two sidearm controllers and the single collective visible.

Safety considerations and additional advantages

Typically, a helicopter is designed around specific requirements, such as the ability to [hover](#) while carrying a certain number of people. For example, if you need to hover with 12 people, the rotor size and power requirements are calculated accordingly. For the S-97, the key design consideration is the power needed to lift the aircraft and push it forward at 220 knots.

The result is that, in hover, there is significant excess power available, power that would otherwise be only used at higher speeds to power the propeller. This provides a substantial safety benefit, especially in multi-engine machines. If an engine fails, there's a high likelihood that a helicopter based on the X2 technology can still hover on a single engine, giving it a strong safety margin.

The design of a helicopter based on the X2 technology has a safety advantage also on single engine machines. In fact, when the engine quits, [autorotation](#) is required to safely land, with the inflow of air through the rotor allowing the aircraft to descend at a controlled rate.

In the event of engine failure during level flight at high speed, the S-97's engine will communicate with the flight control computer, which will immediately begin reducing the blade pitch on the prop. This reduces power demand and creates a decelerating effect on the aircraft, causing air to flow through the propeller and feed energy back into the main rotor. This deceleration helps maintain rotor RPM.



The S-97's peculiar landing gear, which retracts thanks to a swiveling mechanism.

Also, this allows up to 15 seconds of time before needing to lower the collective and begin autorotation, while a traditional helicopter requires much more rapid intervention. This gives the pilot significantly more time to assess the situation and make decisions, evaluating the best options for an emergency landing. The glide ratio is approximately three times better than that of a typical helicopter, offering additional landing options.

Since there is no torque differential between the main rotors, the absence of the tail rotor is not a factor, and the rudders, which remain effective down to 40 knots, are used for yaw control. In the simulator, autorotation has been successfully demonstrated down to 30–35 knots.

While the main propeller of the S-97 is not considered a safety-of-flight element, as the aircraft can operate with or without it, the [tail rotor](#) of a traditional helicopter is a critical safety component. Also, the main propeller is not connected to the aircraft's hydraulic system, while the tail rotor relies on hydraulics, making it more vulnerable to ballistic damage.

For new pilots, the X2 is actually considered easier to fly due to its higher stability and augmentation modes which assist the pilots. For an instance, pilots can start in attitude command mode, where the computer holds the altitude and assists with hover, and then they can gradually transition to more dynamic flight modes.

The fly-by-wire system (FBW) also simplifies an eventual transition to unmanned operations. In fact, since the FBW system already includes a comprehensive set of sensors and controls, adding [unmanned capabilities](#) requires only software modifications and minimal additional effort, compared to conventional aircraft that lack FBW systems.



The S-97 Raider maneuvers during the flight demonstration on Feb. 12, 2025.

The Raider X

While we're here, it is worth looking at a brief recap of the aircraft that the was benefiting from the S-97 demonstrator.

The [Raider X](#) is a scaled-up version of the S-97 Raider, with a side-by-side cockpit to widen the fuselage and increase the payload carried in the internal weapon bays. Speaking about the payload, Lockheed Martin (which acquired Sikorsky in 2015) published a new concept art that showed for the first time the Raider X with its weapon bays open and the turret for the 20 mm cannon in front of the cockpit.

The Raider X is 20% larger than the S-97, with the main rotor going from a 34 feet (10.4 m) diameter to a 39 feet (11.9 m) diameter and the weight increased from 12,000 pounds to 14,000 pounds (5,445 to 6,350 kg). According to the company, Raider X is capable of low and high-speed maneuvers exceeding 70° bank angle.

The helicopter uses a single T901 engine that could propel it well over the 180 knots requirement, as the less powerful [S-97](#) already reached 207 knots in level flight and 250 in a shallow dive during testing. The engine is mounted in a classic central position, with air intakes on both sides and the exhaust contained in the tail boom.

In late 2023, the Raider X prototype was said to be 98% complete, as the aircraft awaited the completion of the GE T901 Improved Engine Turbine Program (ITEP). The Raider X team immediately started the installation process of the new engine upon arrival in October, with the plan to allow the prototype, after a first ground testing phase, to take to the skies within a year.



The Raider X design pitched by Sikorsky for the U.S. Army FARA program. (Image credit: Sikorski/Lockheed Martin)

Let's See What the S-97 Raider and the X2 Technology Are Capable Of



The Raider maneuvers around a fixed point on the runway.

During the X2 Technology Demonstration, the S-97 Raider performed a flight display to show the capabilities the X2 technology.

On Feb. 12, 2025, during the second day of the X2 Technology Demonstration event at the Sikorsky Development Flight Center, the S-97 Raider flew a display to show its capabilities, which differentiate it from traditional helicopters. As mentioned in the [first part of this report](#), *The Aviationist* was among the outlets that were invited to attend the event and see the S-97 demonstrator in action.

The flight display was preceded the day before by a simulator session and a briefing with Sikorsky's experimental pilot Bill Fell, who also flown the S-97 in the demonstration. The briefing allowed a better understanding of the maneuvers demonstrated in the simulator and the ones of the actual flight display.

A great emphasis was put on the acoustic signature and the pusher propeller. The sound is already much lower than a traditional helicopter, as we had the chance to experience the day before when an [S-92](#) departed from the facility for a test flight.

To give a better idea, the helicopter was on the ramp while we were walking around the static S-97 in the hangar, about 50 meters away, and it was difficult to hold a conversation. While the S-97 was hovering in front of the attendees at the same distance, the problem was not as prominent, and we could easily continue to conversate and hear Sikorsky's officials describing the demonstration.

During the various maneuvers, the sound of the S-97 was audible only once the aircraft started coming into sight, giving only a few seconds of heads up to look for it in the sky. For an instance, many attendees noticed the S-97 sneaking up at high speed from behind the audience only when it was directly overhead.

The pusher propeller can allow multiple different uses, in addition to simply providing higher speed. As it was [demonstrated](#) throughout the demo (and explained here in the next paragraphs), the propeller can be used to change the

attitude of the helicopter during the hover, to push it at higher speed or to slow it down, acting as a brake.

A notable example worth mentioning would be the ridge crossing during a terrain following flight, or [nap-of-the-earth](#) as it is called. Usually, while climbing over a ridge to cross it, the pilots have to carefully manage their kinetic energy to avoid ballooning up high above the ridge and exposing themselves to threats.

By using the pusher propeller with a negative pitch while closing in on the ridge, the helicopter can dissipate the excess energy and make sure to stay as close as possible to the ridgeline. Also, while descending on the other side, the prop can be used to slow down and keep a constant speed, which allows to stay as much as possible close to the grounds. The one just described was one of the maneuvers we tested in the simulator.

Let's now describe the main maneuvers demonstrated during the flight display.

Precise Low-Speed Handling

The S-97 has demonstrated during testing the ability to fly at 50 knots in sideward flight, while during the demo the aircraft performed the maneuver between 30 and 40 kts. This type of maneuver can also be performed by traditional helicopters, but there is a difference.

Instead of relying on tail rotor for yaw control, the Raider utilizes the torque differential between its coaxial main rotors to achieve the same effect. In conventional helicopters, tail rotor effectiveness varies based on flight direction and wind conditions, leading to different handling characteristics. In contrast, the X2 technology maintains consistent yaw control regardless of direction, improving maneuverability in low-speed operations.



The S-97 demonstrates its low speed handling.

Level-Body Acceleration

The pusher propeller enables acceleration in level flight. Initially, when starting to move forward, the aircraft tilts its rotors forward to increase airspeed, using the main rotors for initial thrust before engaging the pusher propeller. This way the S-97 can get "a bigger bite of the air" until airflow is established through the propeller, allowing to add power and bring the nose up, so that the aircraft transitions smoothly to forward flight, maintaining a level attitude.

"It's just using the machine in the best possible way," said Fell. "When you're in a hover, you're using this big rotor to grab a big bite of the air and accelerate quickly. It's a good feeling in the aircraft because you can start asking for the prop and you feel that inflow build, almost like a turbo kicking in, and you can start flying more like an airplane."

The X2 is designed with a clutch-controlled pusher prop, allowing the pilot to engage or disengage forward or reverse thrust as needed. The system allows the pilot to apply forward or reverse thrust throughout the flight envelope.

This way, the aircraft can accelerate from a hover like a conventional helicopter, engage the pusher prop at 100 knots, and continue forward flight efficiently. It's up to the crew to decide how they want to operate the aircraft, without having restrictions on the usage of the pusher propeller.

During flight testing, an issue with the pusher prop required its temporary removal. The prop was replaced by a ballast and the S-97 continued testing, reaching 150 knots without problems. This further demonstrates how the presence of the prop does not restrict the operation of the aircraft, except for the maximum speed achievable.

High Turn Rate Maneuverability

To achieve tight turns, the S-97 can add reverse thrust on the pusher prop to decelerate while maximizing load factor, close to 3G, with a bank angle of 60°. As the aircraft exits the turn, forward thrust is reintroduced to regain speed efficiently. This method allows to reduce the turn radius as much as possible while still exiting the turn at high speed.

Such feature would be particularly useful for [evasive maneuvers](#) when a popup threat requires a quick change of direction even when flying at higher speeds. In fact, usually, the higher the speed, the higher the turn radius.



The Raider performs a 60° angle of bank turn to reverse its course.

200 kts High-Speed Cruise Flight

The X2 can maintain a sustained cruise speed of 200 knots at low altitude while retaining responsive maneuverability. The aircraft's roll control and agility allow it to navigate obstacles easily.

"I've flown the aircraft at treetop level at 200 kts and maneuvered around and below the trees. The X2 technology has an amazing roll response and maneuverability to be able to react to any obstacles coming at you quickly" said Fell. "I feel that if you get to like 250 kts you'd better be 50 ft or 100 ft off the ground because you need a little bit more clearance from the terrain."

Speed performance depends on engine power, payload, and propeller configuration. When reaching 100 knots in the S-97, as this Author has experienced himself in the simulator, the collective is programmed to go down, resulting in 90% of the power being directed to the pusher propeller, with the remaining 10% is allocated to the main rotors.

This might seem a bit counterintuitive for pilots, explained Fell, as in traditional helicopter the collective stays up at higher speed. In the S-97, with the Advancing

Blade Concept, the helicopter can reduce rotor pitch while flying at high speed and rely primarily on the pusher prop for thrust.

Dive on Target

A maneuver simulated during the demonstration was a target engagement. For that, the S-97 assumed a 20–30° nose-down attitude throughout the dive while maintaining a constant speed by using the pusher prop as a brake, adding negative pitch.

This is particularly beneficial for attack missions utilizing [unguided weapons](#), as a steeper dive reduces dispersion and increases accuracy, said Fell. Also, the ability to control the descent rate without accelerating allows not only for improved targeting precision, but also for more time on target before having to break off the dive.



Level-Body Deceleration

The X2's ability to decelerate while maintaining a level attitude can enhance operational safety. When landing in traditional helicopters, the deceleration

requires raising the nose, which can reduce visibility in one of the most critical phases of flight, particularly when approaching an unfamiliar landing zone at night or with [low visibility](#). The X2 allows pilots to slow down while maintaining an unobstructed view of the landing area, improving situational awareness and reducing risk, whether in military or civilian applications.

"You're coming in a landing zone in the middle of the night, you may be browning out, you have not been there before, if you're lucky you got some satellite imagery of that place, there could be wires that you couldn't see, and it would be nice to keep looking at that place while you're coming in to land and insert the assault force," said Fell providing an example. "In a traditional helicopter you have to raise the nose and, if you're lucky, you can still see something through the chin bubble or you're able to peek over the dash a little bit, while with the X2 you can slow down and look out the entire time without raising the nose."

Such a feature can greatly improve the safety of flight regardless of military or civil aviation. Another great example provided by Fell was a MEDEVAC (Medical Evacuation) helicopter having to land on a highway to rescue the victims of a car crash. Not only the highway could be considered as a [confined space](#), and it could also include many obstacles like light poles, wires, signs, so having a good visibility during the landing is fundamental.



The S-97 hovers in a nose up attitude assisted by the propeller.

Nose-Down Hover

The X2 technology allows to hover in either a nose-up or nose-down attitude by adjusting the pusher propeller's thrust. This feature, for an instance, can enhance reconnaissance and observation missions by providing better visibility of a target area. Currently, these adjustments require manual control through cyclic, collective, and propeller inputs, but future developments could introduce an automated function to simplify operation for the pilot and reduce the workload.

Hover with propeller disengaged

By disengaging the pusher prop, the -97 significantly reduces its acoustic signature. In fact, similar to how a tail rotor contributes to noise in conventional helicopters, the pusher prop is a primary source of sound in the X2 technology. When declutched, the propeller rotates at low speed, reducing the noise in what Sikorsky calls the "Whisper Mode". Also, the coaxial main rotors operate at reduced RPM compared to a single main rotor, further decreasing noise levels.

This reduction in acoustic signature is advantageous not only in military operations, where stealth is a priority, but also in civilian applications, particularly in heavily populated urban environments, where lower noise emissions can improve operational viability.



XB-1 Completes Test Program with Second Supersonic Flight



On February 10, 2025, XB-1 once again flew faster than the speed of sound, collecting key data on civil supersonic flight. Reaching new heights at 36,514 feet, Boom Chief Test Pilot Tristan “Geppetto” Brandenburg took XB-1 to a top speed of Mach 1.18 (671 KTAS, or 772 mph).

The mission of XB-1's second supersonic flight was to continue to assess aircraft performance and data collection above Mach 1, including capturing acoustic sonic boom data and specialized photography known as Schlieren images—read on below to learn more and see the iconic image.

During the 41-minute flight, the aircraft broke the sound barrier three times—all without creating sonic booms that could be heard on the ground.

XB-1's second supersonic flight marks the conclusion of its groundbreaking flight test program. XB-1 will now return to her birthplace in Denver, Colorado, as Boom now focuses its full efforts on scaling XB-1 learnings and technology to build the Overture supersonic airliner.

Follow the link below to view a replay of the livestream, hosted by Founder and CEO Blake Scholl and Chief Flight Test Engineer Nick Sheryka.

MAR 3, 2025

Boom Supersonic Partners with NASA to Capture Iconic Image of Civil Supersonic Flight

Specialized photography from NASA shows the shock waves as Boom's supersonic demonstrator breaks the sound barrier. Boom confirms no sonic boom reached the ground during XB-1 demonstrator's supersonic flights.

MOJAVE, CA and DENVER, March 3, 2025 — **Boom Supersonic**, the company building the world’s fastest airliner, Overture, partnered with NASA to capture specialized photography during supersonic flight tests of its demonstrator aircraft, XB-1. During XB-1’s second supersonic flight on February 10, 2025, NASA teams on the ground used Schlieren photography, a technique to visualize the shock waves resulting from XB-1 pushing through the air at supersonic speeds. In January, XB-1 became the first independently developed jet to fly faster than the speed of sound, and the first civil supersonic jet built in America.

NASA teams also collected data on XB-1’s acoustic signature at one location on the flight route. Boom analysis found that no audible sonic boom reached the ground as the jet flew at supersonic speeds.

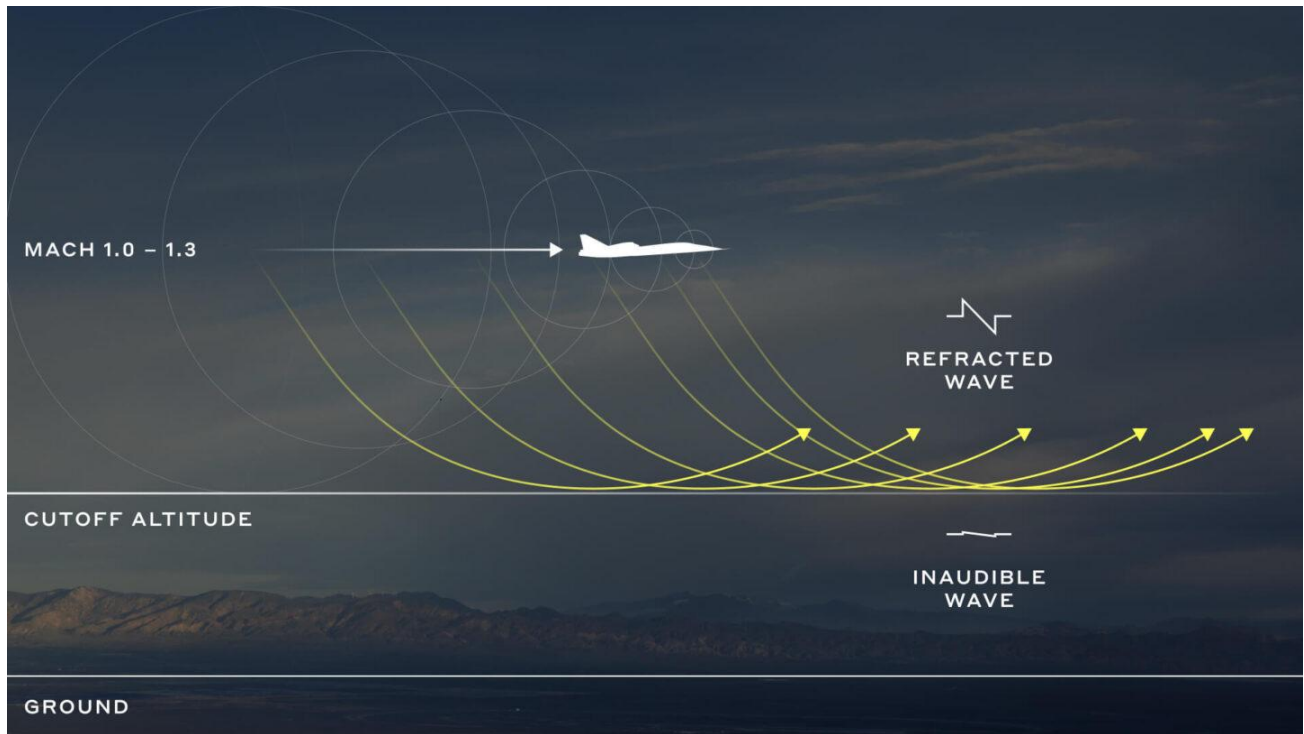
“This image makes the invisible visible—the first American made civil supersonic jet breaking the sound barrier. Thanks to Geppetto’s exceptional flying and our partnership with NASA, we were able to capture this iconic image,” said Blake Scholl, Founder and CEO of Boom Supersonic. “We also confirmed that XB-1 made no audible sonic boom, which paves the way for coast to coast flights up to 50% faster.”

Taking Schlieren images requires ideal conditions and timing, and exceptional flying by the pilot. Boom Chief Test Pilot Tristan “Geppetto” Brandenburg positioned XB-1 at an exact time in a precise location over the Mojave Desert to enable NASA to photograph XB-1 flying in front of the sun, documenting the changing air density around the aircraft at speeds exceeding Mach 1.

Photo credit: NASA/Boom Supersonic

Using waypoints computed by NASA, the XB-1 team rapidly developed avionics software to guide the pilot to the specific points in space that XB-1 would have to fly through in order to eclipse the sun. To capture the imagery, NASA used ground telescopes with special filters that detect air distortions, such as shock waves, around the supersonic aircraft.

Efforts conducted by both NASA and Boom while modeling the expected flight parameters of XB-1’s supersonic flights estimated a very high likelihood of operating at Mach cutoff, in which a sonic boom refracts in the atmosphere and never reaches the ground. This effect is achieved by breaking the sound barrier at a high enough altitude, with exact speeds varying based on atmospheric conditions.



Source: Pennsylvania State University Acoustical Model of Mach cutoff Flight

Sonic boom data was captured with microphones and sound pressure level recording devices positioned in limited strategic locations in relation to the flight path. Boom's assessment of this type of data from XB-1's supersonic flights demonstrates that supersonic flight without the disturbance of a sonic boom is possible. This aligns with [research](#) previously conducted by NASA in efforts to bring supersonic commercial travel to the public.

On February 10, Boom announced that it will use data the company collected from XB-1's test flight program to bring [Boomless Cruise](#) to its supersonic airliner, Overture. Boomless Cruise enables Overture to fly at speeds up to Mach 1.3 without an audible boom, reducing U.S. coast-to-coast flight times by up to 90 minutes.

XB-1's second supersonic flight marked the conclusion of its groundbreaking flight test program, and the historic aircraft will now return to her birthplace in Denver, Colorado. Boom will now focus its full efforts on scaling XB-1 learnings and technology to build the Overture supersonic airliner, which already has 130 orders and pre-orders from United Airlines, American Airlines, and Japan Airlines. In 2024, Boom completed construction on the Overture Superfactory in Greensboro, North Carolina, which will scale to produce 66 Overture aircraft per year.

About Boom Supersonic

Boom Supersonic's mission is to make the world dramatically more accessible through flights that are faster, more affordable, more convenient, and more sustainable.

Boom is developing Overture, the world's fastest airliner, optimized for speed, safety, and sustainability. Overture will fly at twice the speed of today's airliners and is optimized to run on up to 100% sustainable aviation fuel (SAF). Overture's order book stands at 130 aircraft, including orders and pre-orders from American Airlines, United Airlines, and Japan Airlines. Boom is working with Northrop Grumman for government and defense applications of Overture. Suppliers and partners collaborating with Boom on the Overture program include Aernnova, Aciturri, Collins Aerospace, Eaton, Honeywell, Latecoere, Leonardo, Safran Landing Systems, Universal Avionics, and the United States Air Force.

Symphony™ is the purpose-built turbofan engine that will enable supersonic flight. The Boom-developed engine is supported by world-class suppliers including Florida Turbine Technologies (FTT), a Kratos company, Colibrium Additive, and StandardAero.

XB-1 is Boom's technology demonstrator aircraft and the world's first independently developed supersonic jet. The aircraft first took flight in Mojave, CA in March 2024 and completed a series of flight tests, culminating in its first supersonic flight in January 202

X-37B: US military's mini space shuttle lands after record 434-day secret mission



X-37B: US military's mini space shuttle lands after record 434-day secret mission

On March 7, 2025, at 02:22 am EST, the U.S. Space Force's X-37B Orbital Test Vehicle-7 (OTV-7) successfully deorbited and landed at Vandenberg Space Force Base in California.

This unmanned spaceplane has been pivotal in testing new technologies and operational techniques in space.

Mission 7 marked a significant milestone as it was the first mission to launch on a SpaceX Falcon Heavy Rocket, setting a course for a Highly Elliptical Orbit.

Refreshing the importance of flexibility in space operations, the X-37B demonstrated its capability to launch and recover systems across multiple sites, a move aimed at enhancing operational readiness.

U.S. military's mini space shuttle

During its orbit, the X-37B conducted experiments and tests to evaluate its maneuverability and collect data on the space environment.

One of the standout accomplishments of Mission 7 was its successful execution of a novel aerobraking maneuver, which showcased the spaceplane's ability to adjust its orbit smartly while conserving fuel.

The technique relies on atmospheric drag over multiple passes to gradually change orbits, an approach gleaned from years of aerospace experience.

Chief of Space Operations Gen. Chance Saltzman emphasized the significance of these achievements.

"Mission 7 broke new ground by showcasing the X-37B's ability to flexibly accomplish its test and experimentation objectives across orbital regimes," he stated.

He further noted that the success of the aerobraking maneuver illustrates the Space Force's ongoing commitment to advancing innovative space operations safely and responsibly.

While in orbit, Mission 7 also focused on testing space domain awareness technologies.

These experiments aim to enhance the U.S. Space Force's understanding of the increasingly congested and contested space environment.

Such advancements are critical not only to the mission of the Space Force but also to all entities relying on the shared domain of space.

Lands after record 434-day secret mission

Following its successful aerobraking to a Low Earth [Orbit](#) and the completion of its experimental objectives, the X-37B executed its deorbit and landing procedures flawlessly.

The seventh mission was notable for its duration, remaining in orbit for more than 434 days, an impressive feat that further established the X-37B's robust capabilities.

Lt. Col. Blaine Stewart, the X-37B Program Director, [remarked](#) on the implications of Mission 7.

"Mission 7's operation in a new orbital regime, its innovative aerobraking maneuver, and its testing of space domain awareness experiments mark a pivotal moment in the X-37B program. Together, they signify an important development in the U.S. Space Force's evolving mission capability."

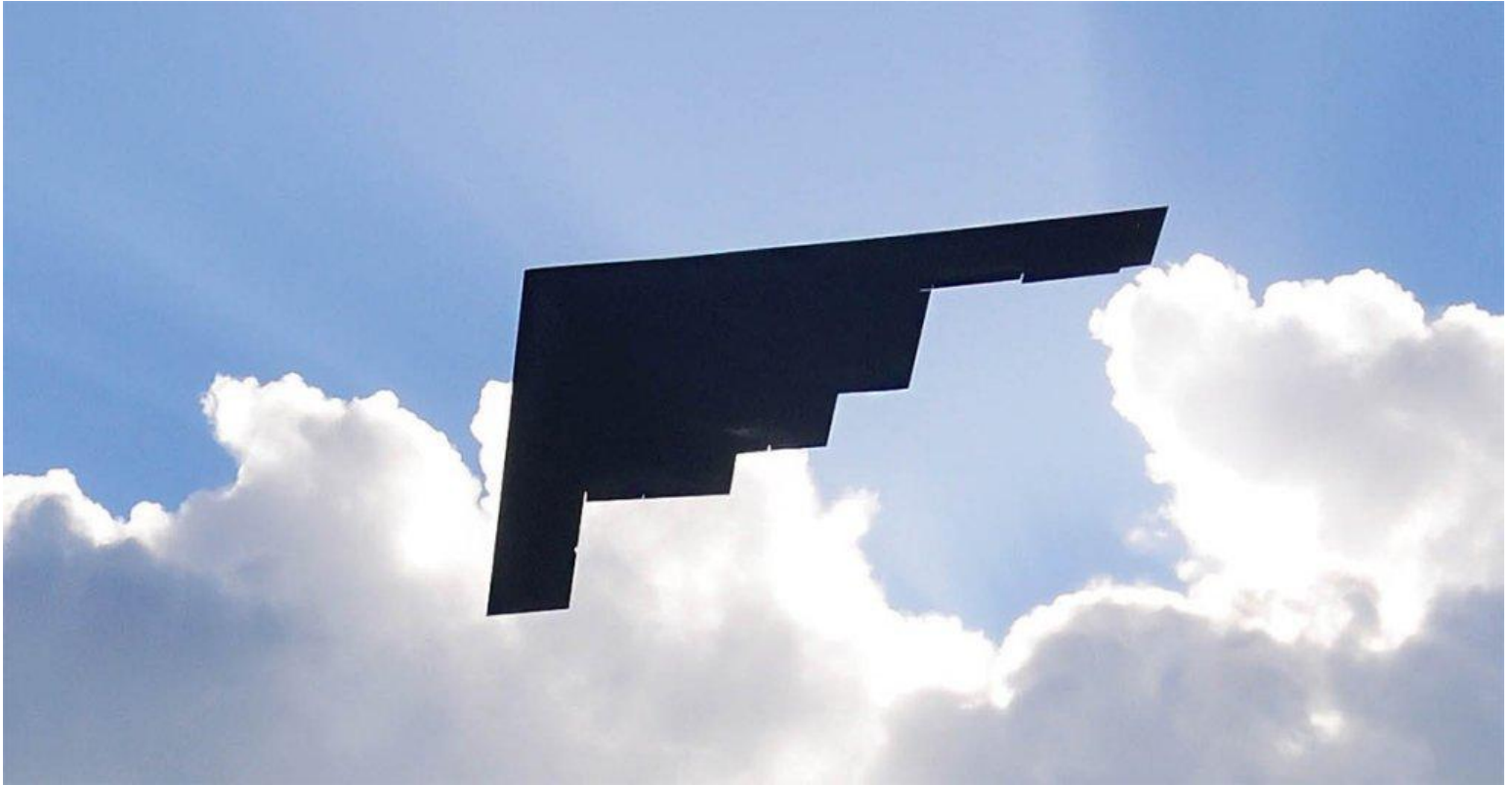
The success of Mission 7 highlights the X-37B Orbital Test Vehicle's role as a versatile asset in the U.S. Space Force's strategy to enhance national security through improved operational intelligence and technological advancement.

As the challenges in space become more complex, initiatives like these are crucial for ensuring that the U.S. maintains its leadership and readiness in space operations.

With this mission, the X-37B continues to pave the way for [future](#) innovations in aerospace technology and strategy while reinforcing the importance of adapting to the dynamic nature of space exploration and utilization.

How the legendary B-2's stealth actually works

The B-2 Spirit is one of the most clandestine and rare planes in the world. Only 21 were ever built, and they



reportedly have a stealth profile similar to that of a large bird despite their 170-foot wingspan. And they're invisible to many infrared ...

Updated on Apr 4, 2023

The B-2 Spirit is one of the most clandestine and rare planes in the world. Only 21 were ever built, and they reportedly have a stealth profile similar to that of a large bird despite their 170-foot wingspan. And they're invisible to many infrared seekers, despite four large engines.

Here's how engineers made a massive plane with large engines nearly invisible to systems designed to detect threats exactly like the B-2.



The B-2's stealth profile is the result of extensive computer testing that wasn't possible before its design. While the F-117 and B-1 were stealth aircraft, they were designed by nerds with slide rules and minimal computer modeling because the technology and the computers necessary simply didn't exist.

But when it was time to design the B-2, the all-powerful nerds had super computers and leveraged them to create a model that had no flat surfaces with which to reflect radar directly back to the sensor. While a machine with no flat surfaces is harder to manufacture, the increase in stealth was deemed worthy of extra costs.

If the B-2 were flying directly towards the radar, most of the waves would actually be reflected 90 degrees away from the receiver, giving the radar operators next to nothing to work with.



Husband and wife B-2 Spirit pilots pose with one of the rare aircraft. The engine intakes are visible to the left and right of the cockpit. (Avery family courtesy photo)

But of course, the flying wing would lose most of its stealth if the engines were mounted outside of its high-tech form. So the engines were mounted inside with special openings for intake and exhaust that, again, would not reflect radar waves back to the dish. That exhaust opens its own can of worms. After all, aircraft can be tracked by their infrared signatures, if only from relatively close ranges. So, the [B-2 needed tech that would let it diffuse or mask its infrared emissions](#) at ranges as short as possible.

It has a few (mostly classified) systems to help with this. The exact shape of the exhaust helps a lot, but it also cools its exhaust and mixes it with the outside air to create a final exhaust that is at nearly the same temperature as the air flowing into the intake.

U.S. Air Force Tech. Sgt. Germaine McCall, aircrew flight equipment NCO in charge, 509th



Operations Support Squadron, carries a life support equipment to be cleaned and inspected upon the arrival of a B-2 Spirit at Joint Base Pearl Harbor-Hickam, Hawaii, August 28, 2018. (U.S. Air Force Staff Sgt. Danielle Quilla)

This greatly frustrates pursuing missiles and fighters, but obviously still leaves it vulnerable if someone spots the plane and talks fighters into the vicinity to hunt it. Except the B-2 has another trick up its sleeve that makes even that less likely. It's actually extremely quiet, so much so that [people at sporting events with B-2 flyovers have reported being able to speak to one another as the plane flies past](#).

Anyone who has worked with most other jets knows that you can typically hear them before you see them, often by a matter of hundreds of feet. It's the sound that lets you know to look for the plane, but the B-2's tiny acoustic signature means that most observers on the ground won't know there's anything in the sky to look for.



A U.S. Air Force B-2 Spirit flies past a crowd of spectators during the 2018 Royal International Air Tattoo at RAF Fairford, United Kingdom on July 14, 2018. (U.S. Air Force Tech. Sgt. Brian Kimball)

Combined, this makes the B-2 a plane with little radar observability, that's too quiet for most people on the ground to notice it flying nearby, and it gives off little heat, frustrating missiles and fighters sent to down it.

All of this still requires good pilots and planning. Determined defenders could use low-frequency radar waves and skilled fighters to hunt down a B-2 following a too-populated or well-defended route. But the last element of B-2 stealth comes from good intelligence, allowing pilots and planners to send the bombers in through relatively undefended routes or through routes the B-2 can defeat.

Because that's a big part of the B-2's mission. It's not supposed to act as the primary bomber in most circumstances. It's a first-wave attacker, clearing the air defenses on the ground and opening "alleys" for less stealthy aircraft. Ideally, they get a picture of the air defenses they will attack from reconnaissance aircraft like the RC-135 and are then able to dismantle them piece by piece.



An Air Force B-2 Spirit bomber, deployed from Whiteman Air Force Base, Mo., takes off March 27, 2016, in the U.S. Pacific Command area of operations. (U.S. Air Force Senior Airman Joel Pfister)

But the B-2 can and has been sent against other targets, including bunkers in Iraq housing command and control elements during the invasion of that country. This is particularly useful when planners need to eliminate a target too early in the timeline to dismantle the air network first.

After all, if an enemy commander shows himself at a rally in the capital during an air campaign, you aren't going to wait for the B-2s to finish opening the air corridors, you're just going to send in B-2s to the final target (or [you send B-1s](#) if the B-2s can't get there in time). You can get the radars later.

And that's what's so great about the B-2. While the plane costs more dollars per hour of flight than many others and carries fewer bombs than planes like the B-52 and B-1, it can hit targets that few other platforms can, largely because of its amazing stealth.

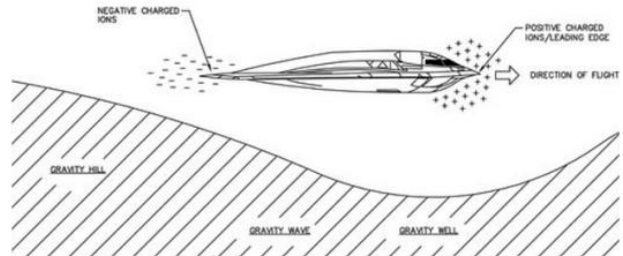
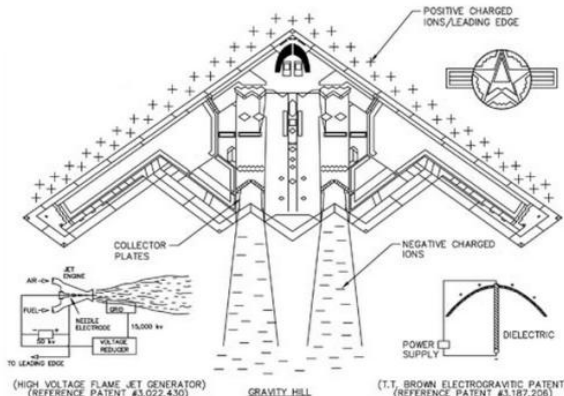
How The B2 Bomber Is Powered By UFO Technology - Electrogravitics

The Classified Technology Goes Against Mainstream Science



The B2 Bomber as it breaks the sound barrier

The B2 Bomber Uses It's Jet Engines To Generate Electricity



THE 2.3 BILLION DOLLAR FLYING CAPACITOR

AVIATION WEEK AND SPACE TECHNOLOGY (MARCH 9, 1992) REPORTED THAT THE NORTHROP B-2 ATB STEALTH BOMBER UTILIZES A NUMBER OF CLASSIFIED "BLACK" TECHNOLOGIES DESIGNED TO ENHANCE ITS "STEALTH" CAPABILITIES. ONE TECHNIQUE REPORTED IN THE AVIATION WEEK ARTICLE INDICATED THAT THE B-2 ELECTRICALLY CHARGES ITS WING LEADING EDGE TO REDUCE THE RCS (RADAR CROSS SECTION). THE ARTICLE WENT ON TO SAY THAT THE EXHAUST GASSES OF THE B-2 ARE NEGATIVELY CHARGED TO REDUCE ITS INFRARED SIGNATURE (IR). THIS PROCESS OF POSITIVELY CHARGING THE LEADING EDGE, AND NEGATIVELY CHARGING THE EXHAUST GASSES IS VIRTUALLY IDENTICAL TO THE ELECTROGRAVITIC PROPULSION SYSTEM DEVELOPED BY THOMAS TOWNSEND BROWN IN 1925. THIS SYSTEM PRODUCES A GRAVITY "WELL" IN FRONT OF THE CRAFT, AND A GRAVITY "HILL" BEHIND THE CRAFT, WHICH ALLOWS THE B-2 TO RIDE ON A "GRAVITY WAVE", SIMILAR TO A SURFER RIDING A WAVE ON THE OCEAN. THE FOUR F-119-C2-100 ENGINES INSIDE THE B-2 SERVE AS "FLAME JET GENERATORS", PRODUCING UP TO 100 MEGAWATTS OF ELECTRICAL POWER. THIS ELECTRICAL POWER CAN BE STORED DIRECTLY INSIDE THE STRUCTURE OF THE B-2 WHICH IS PRIMARILY MADE UP OF AN ADVANCED DIELECTRIC CERAMIC MATERIAL, AND ESSENTIALLY TURNS THE B-2 INTO ONE LARGE CAPACITOR. ONCE THE "GRAVITY WAVE" IS ESTABLISHED, THE ENGINES ON THE B-2 CAN BE SHUT DOWN, TURNING THE CRAFT INTO AN "OVERDRIVE DEVICE", THAT CAN FLY AT SUPERSONIC SPEED, WITH AN UNLIMITED RANGE.

The technology is not accepted by mainstream science because it is classified.

Electrogravitics

By charging the front end of an object with a powerful positive charge and the rear of the object with a high voltage negative charge, it creates a gravitational well in front of it and a gravitational hill at the rear, this generates propulsion in a forward direction.

This was first experimented by **Thomas Townsend Brown** in 1921.

Some sceptics say the highly powered current creates an ion wind which the object can ride on making this electro-kinetics. Electro-kinetics is accepted by mainstream science, unlike electrogravitics. But this is because it is classified technology.

To prove that the newly discovered type of physics was not related to electro-kinetics, Brown tested his experiment in a vacuum and said that it worked more effectively. In a

vacuum ions have no mass and **de-materialise** proving that the effect is not because of ion wind.

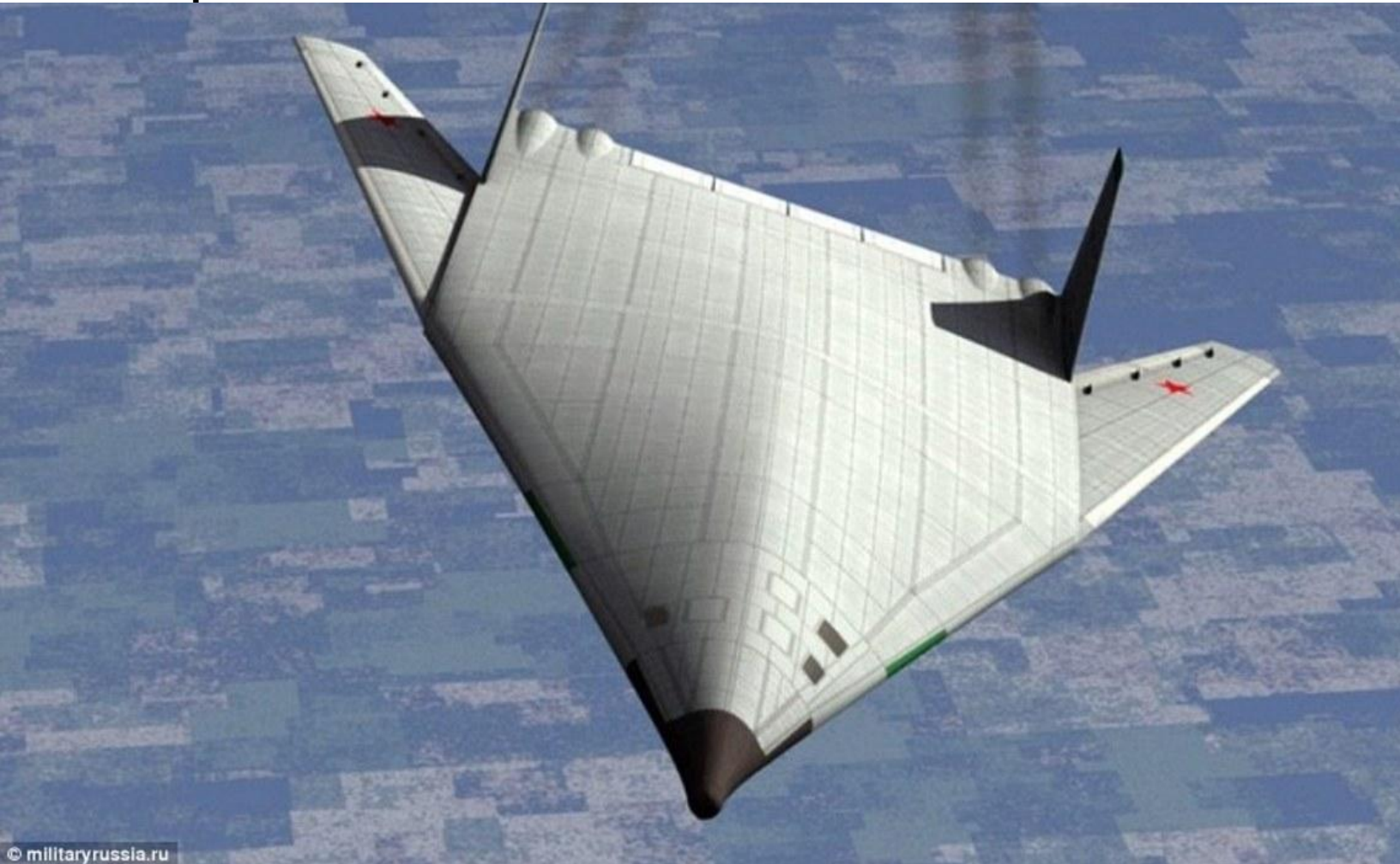
In 1953 Brown had made significant advances in his research and demonstrated the technology to some "top brass" in Pearl Harbour.

A year later his project was classified by the military, making the advanced propulsion technology inaccessible to the public.

The B2 Stealth Bomber uses it's jet engines mainly to produce the high voltage needed to power the unearthly technology. The front of the wings are charged with positive electrons while the tail and exhaust fumes are charged with negative electrons to create gravitational repulsion. This should not be possible according to Einstein's theory of relativity.

Although electrogravitics is not taught by mainstream scholars due to the secrecy surrounding it, scientists at **CERN's** Large Hadron Collider (**LHC**) and other large particle colliders round the world are researching to try and find the physics of the phenomenon.

Russia's New Hypersonic Stealth Bomber Can Reach Space



The PAK-DA is also thought to be using electrogravitics as propulsion.

Russia Has An Answer to The B2 Bomber

In recent news President Vladimir Putin has rised the bar in military aviation by showing off his new hypersonic stealth bomber which can launch a nuclear attack from space.

The **PAK-DA** could be fully operational by 2020 and is thought to have already been on test flights. This craft which looks quite similar to NASA's space shuttle could reach any

destination in the world within 2 hours. The **PAK-DA** is thought to also be using electrogravitic technology for propulsion.



T-38 failure analysis of an upper cockpit longeron for safety of flight and sustainment

Author links open overlay panel Mirella Vargas ^a, Laura D. Hunt ^b, David H. Wieland ^b, John H. Macha ^a

Highlights

- • High cycle fatigue was resolved as the primary damage mechanism on a T-38 Upper Cockpit Longeron.
- • Two concurrent fatigue cracks initiating from a fastener hole were resolved.

- •
Damage tolerance and risk analyses were updated to set the required inspection frequency based on the two cracks.
- •
Without the failure analysis, fleet management decisions would not have reduced the risk to an acceptable level, ultimately minimizing the effect on fleet availability.

Abstract

The United States Air Force supersonic T-38 trainer Aircraft Structural Integrity Program (ASIP) utilizes failure analysis to help maintain safety of flight and sustainment. A failure analysis was performed on a cracked upper cockpit longeron. When the failed longeron was first discovered, an emergency inspection was performed of all the T-38 longerons before the next flight. The preliminary risk assessment was critical for ensuring the fleet was safe to fly until a more detailed analysis and better inspection techniques could be developed.

The metallurgical examination demonstrated the cracked longeron to exhibit a fracture face spanning the entire cross-section, which included the walls on the inboard, outboard, and upper faces of the part. The total length of the fractured area was approximately 6.5 in., with multiple initiation points originating at the longeron fastener holes. The fractographic analysis validated the damage tolerance analysis, and evaluation of additional fatigue cracks in longerons removed from service were used to develop an equivalent initial flaw size distribution for input into the risk assessment. The updated damage tolerance analysis (DTA) along with the equivalent initial flaw size distribution was used in the updated risk analysis to determine the viability of various inspection techniques and appropriate recurring inspection intervals to maintain safety of flight.

Introduction

The T-38 Talon is a supersonic jet trainer (Fig. 1) designed in the late 1950 s primarily for static strength and fatigue [1]. The first DTA was conducted in the late 1970 s. The

usage severity has increased over the years, with two missions routinely analyzed: moderate and severe. The T-38 is scheduled to remain in service to 2035 and beyond, thus a rigorous maintenance and structural modification plan is in place [1].

Over the years, the T-38 Talon has undergone numerous modification programs including Pacer Classic I and II, Avionics Upgrade Program; and the Propulsion Modernization Program. The Pacer Classic III (PCIII) is the latest fuselage structural modification program based on results from full-scale fatigue tests, teardown analysis, and independent evaluations. Full-scale fuselage fatigue tests performed at Southwest Research Institute® (SwRI®) demonstrated the top three life-limiting structural items to replace would be the dorsal longeron (primary), the upper center longeron, and the upper cockpit longeron. Analytical Condition Inspections (ACIs) are performed during PCIII on the three longerons with a worst-first philosophy, meaning the fuselages with the highest equivalent flight hours are modified first with the focus on the three longerons. The ACIs have provided and continue to provide lead-the-fleet information from analysis of replaced parts being sent out for failure analysis.

In the Spring of 2017, a large crack was discovered in the right-hand upper cockpit longeron as shown in Fig. 2. This was the first field finding at this location. Subsequent inspection of all jets prior to the next flight was completed within four days, and no additional cracks were discovered. The effective and efficient inspections were attributed to a streamlined process beginning with a visual inspection. Removal of a door provided the access necessary to the underside of the upper cockpit longeron. This paper describes the feedback loop processes employed from the initial field finding, preliminary DTA, the metallurgical failure analysis, and combination of the data and results from all three sources to update the DTA and decrease risk for future safety of flight related to the fatigue critical longerons.

Section snippets

Preliminary damage tolerance and risk analysis

The novel crack location on the right-hand upper cockpit longeron was similar to existing fatigue critical locations. The preliminary DTA modified the forward fuselage finite element model to better represent the geometry of interest. The crack growth

analysis was performed with AFGROW [2]. Durability crack growth curves correlated well with the ACI findings from PCIII lead-the-fleet parts as demonstrated in Fig. 3. Due to the available ACI data and DTA for the new fatigue critical location, a

Experimental

The metallurgical failure analysis of the cracked longeron was carried out by performing a thorough fractographic analysis using macrophotography, optical microscopy and an FEI Quanta 650 Scanning Electron Microscope (SEM). Material evaluation was carried out by preparing metallographic samples using standard laboratory techniques for aluminum. Rockwell hardness measurements were performed using a Wilson Tukon Tester in keeping with ASTM E18. The semi-quantitative compositional analysis of the

Updated DTA and risk analysis

The results from the metallurgical failure analysis were immediately utilized to update the crack growth model and DTA. The original model considered a single crack. The metallurgical findings at the upper fastener hole confirmed two concurrent cracks. The two-crack DTA resulted in a shorter crack growth life, as shown in Fig. 12. Due to the two concurrent cracks, the frequency of inspections of this location on the longerons was increased. The risk analysis based on Single Flight Probability

Conclusions

The robust and timely ACI, damage tolerance, and risk programs allowed for a rapid response to an unknown cracking mechanism present over the upper cockpit longeron. The metallurgical failure analysis was an invaluable tool for discovering the damage mechanism (fatigue), crack morphology, and the existence of two concurrently growing cracks. Without the failure analysis, fleet management decisions would not have reduced the risk to an acceptable level, ultimately minimizing the effect on fleet

CRedit authorship contribution statement

Mirella Vargas: Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Laura D. Hunt:** Writing – review & editing, Investigation, Formal

analysis, Data curation. **David H. Wieland:** Writing – review & editing, Funding acquisition, Formal analysis, Data curation. **John H. Macha:** Writing – review & editing, Supervision, Methodology, Investigation, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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There are more references available in the full text version of this article.

