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INSIDE:

- NEXT-GENERATION ROTARY-WING UAVS
- DEFENSE AIRCRAFT TECH — WHAT'S NEXT?
- THE GLOBEMASTER JUST KEEPS GETTING BETTER

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PUBLISHER
Richard Greenwald

EDITOR
Laura Brengelman

GENERAL MANAGER
Rose Candido

TRAFFIC/PRODUCTION
Karen Duzy

CONTRIBUTORS
Jeff Blundell
Donna J. Kelly
Terry Lloyd
Tracy Martin
Paul McDonnold
Andrea Templeton
Patrick Walsh

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P.O. Box 110382, Naples, FL 34108
P: 914-244-8899
www.wrightmediainc.com
r.greenwald@abdonline.com

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What Is and What Will Never Be

I have always been, and still am, a staunch supporter of Ukraine. On this editorial page in the past, I have noted the support the United States has provided to Ukraine, and called for other world powers to increase their contributions. I also have advocated for the sale to Ukraine of F-16s, along with spare parts and training. More recently, I floated the idea that U.S. *loans* to this country, and to others, should carry the stipulation that they establish defense manufacturing facilities here in the United States. Overall, I would like to see us help level the "fighting field" for Ukraine, while bolstering our defense aviation industry, including the aftermarket, in the process.

Yet recent news in the negotiations to end the war brings to light the blinders that world leaders sometimes wear to avoid undesirable realities. Some months ago, President Volodymyr Zelensky of Ukraine stated that it would be political suicide for his government to recognize Crimea as part of Russia. This position was ludicrous. For fighting to stop and to save Ukraine, Zelensky should have instead focused on negotiating the best terms obtainable for future security against Russian aggression.

The takeover of Crimea by Russia happened years before this war began. Crimea benefits in large part from trading with Russia, including a large tourist industry. The current Crimean population identifies as Russian, and the people of Crimea voted to become part of Russia soon after annexation. Give it up, it is gone.

Otherwise, in spite of Zelensky's heroism during this conflict, it was a poor decision to meet with President Donald Trump in the Oval Office and, in effect, bite the hands that feeds him, rather than expressing gratitude for U.S. support. Right or wrong, Zelensky's actions did not sit well with the American people. And more recent developments, such as the sneak drone attacks on Russian aircraft, may have pushed the situation beyond the point of no return.

Tens of thousands have died in the Ukraine-Russian war on both sides. Stopping the conflict, freezing the borders as they now stand, and instituting a peace-keeping force between the two countries may be the best deal Ukraine can hope for. Though, again, it might be too late for any such resolution. We may soon be talking not about two countries at war, but instead only one country—a new, expanded Russia that has taken over Ukraine in its entirety.

The significance of this ongoing war goes beyond the age-old struggle of one entity attempting to claim and subsume the territory of another. People, especially leaders in such key positions, need to recognize and act upon current realities, rather than steadfast desires, for the greater good. A universal goal of all nations must be to work together and actively support the steps necessary to achieve a more peaceful future worldwide.

Richard Greenwald

Richard Greenwald
Publisher

They also serve who only stand and wait®
John Milton, 1655

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By Terry Lloyd

A rendering of the U.S. Navy's future E-130J TACAMO aircraft. (Courtesy of Northrop Grumman, via DIVIDS.)

Northrop Grumman Prime Contractor for TACAMO Hercules

Northrop Grumman received a $3.5 billion contract to deliver an EC-130J replacement aircraft for the U.S. Navy's current E-6B Mercury nuclear command, control, and communications (NC3) fleet. Northrop Grumman will lead an industry team, with Lockheed Martin and Collins Aerospace as directed subcontractors responsible for airframe production and system integration. Raytheon, Crescent Systems, and Long Wave will also be subcontractors on the team.

For decades, Northrop Grumman has been a key industry partner with the U.S. Navy as a prime defense manufacturer of models such as the E-2D Advanced Hawkeye and the MQ-4C Triton. The company also has provided support for Boeing's E-6B Mercury strategic airborne command post aircraft, as part of the TACAMO (Take Charge And Move Out) program.

The U.S. Navy's TACAMO mission provides survivable, reliable, and endurable airborne command, control, and communications between the National Command Authority and U.S. nuclear forces. The E-130J replacement will modernize the U.S. Navy's critical NC3 command and control of its strategic deterrent forces, though it will not fulfill the E-6B's full Airborne Command Post (ABNCP) mission capabilities.

AGM-158 flight testing begins on F-35C. (Photo by Dane Wiedmann, via DIVIDS.)

Lockheed Martin Receives Missile Contract

Lockheed Martin was awarded a $3.2 billion contract for long-term production of the AGM-158C Long Range Anti-Ship Missile (LRASM) and AGM-158B Joint Air-to-Surface Standoff Missile (JASSM). The contract is part of the U.S. Large Lot Procurement pilot program, intended to help increase annual production by providing resources for long-lead procurements and creating production line efficiencies to increase critical weapons capacity for the United States and its allies.

The LRASM is used by both the U.S. Navy and U.S. Air Force, and Lockheed Martin and the Navy began flight testing of the AGM-158C on the F-35B in March, following tests with the F-35C in fall 2024. Integration for use with the P-8 Poseidon started in 2020. Allies Australia, Japan, and the United Kingdom have expressed interest in obtaining the LRASM.

The stealthy JASSM can be carried by a wide range of aircraft, including the B-1B, B-2, and B-52, F-15E, F-16, F/A-18, and F-35. Japan uses the JASSM and contracted for up to sixteen at a price of $39 million in January. The missile also is in use by Australia, Finland, and Poland.

A CH-47M is shown performing multi-ship flight training. (Georgia Army National Guard Photo by Major Will Cox/Released, via DIVIDS.)

Japan Orders Boeing Block II Chinooks

The Japan Self-Defense Forces (JSDF) has ordered seventeen CH-47JA Block II Chinook Extended Range heavy-lift helicopters to modernize its fleet, replacing some of its CH-47JAs. The rotorcraft will be co-produced by Boeing and Kawasaki Heavy Industries (KHI) under a $1.6 billion contract.

Boeing and KHI have delivered over 100 Chinooks to the JSDF since the 1980s, making it one of the longest lasting and most successful license manufacturing programs in Japan. Japan joins the United States and the United Kingdom in modernizing to the advanced Block II configuration. The extended-range aircraft features an advanced digital cockpit, reinforced airframe, enhanced fuel tanks, and other improvements, enabling increased performance and commonality with the expanding global fleet of updated Chinooks. The updated design and avionics architecture also facilitates future upgrades.

A German Air Force Tornado is refueled by a U.S. Air Force KC-135 over Germany. (U.S. Air Force photo by Technical Sergeant Emerson Nuñez.)

Germany Considers Buying More F-35A Lightning IIs

Numerous industry sources have reported that the German government is interested in purchasing an additional eight to ten Lockheed Martin F-35A Lighting II fighters, possibly to be used for training German pilots in the United States at Ebbing Air National Guard Base in Michigan.

While no contract amount was released, the acquisition cost could be over $2 billion, based on Germany's previous purchase of thirty-five aircraft and missiles for $10 billion in 2022. Delivery to the German Air Force of the first aircraft from that order is expected sometime in 2026. The F-35As will be replacing legacy Tornado aircraft.

A Pratt & Whitney F119-PW-100 turbofan engine run is conducted at Joint Base Elmendorf-Richardson, Alaska. (U.S. Air Force photo by Airman First Class Andrew Britten.)

Two Engine Contracts for Pratt & Whitney

Pratt & Whitney received a $1.5 billion contract for integrated logistics support, including engineering, forecasting, manufacturing, purchasing, and part order for around 400 U.S. Air Force F119 engines over three years. The company stated that it has been working on "incremental modernization" of the F119 engine, which powers the F-22 fighter, including a software update to increase thrust.

Should the U.S. Air Force decide to extend operational use of the F-22, Pratt & Whitney's Usage-Based Lifing data tracking system for the F119 engine would facilitate potential engine upgrades, primarily to control software, to help squeeze out added performance and efficiency.

Pratt & Whitney also received a $186 million U.S. Navy contract for material and support equipment for its F135 engine, which powers the F-35 fighter. The contract includes depot and sustainment activities across all users.

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A combat systems officer station shell sits on a table at Moody Air Force Base, Georgia. The station and software upgrades will support Link 16, a tactical data network system that can establish communication between aircraft for a full picture of a battlespace. (U.S. Air Force photo by Senior Airman Deanna Muir.)

L3Harris Technologies to Provide Resilient Comm Tech

L3Harris Technologies received an indefinite delivery and quantity contract award, worth up to $999 million over the next five years through the U.S. Navy to provide the United States and coalition forces with resilient communications technology. This deal continues L3 Harris's 24 years of delivering standard communications interoperability solutions to the U.S. armed services and numerous allied nations.

The company will deliver its Multifunctional Information Distribution System Joint Tactical Radio System Terminals (MIDS JTRS) solution, which is a critical, software-defined Link 16 resilient communication radio for various air, ground, and maritime platforms. L3 Harris, along with Data Link Solutions (DLS) are the two providers of MIDS JTRS.

(Image courtesy of the U.S. Air Force.)

Gulfstream Aerospace Supports U.S. Air Force C-20/C-37 Fleet

The U.S. Air Force Life Cycle Management Center awarded Gulfstream Aerospace a contract to provide services to the U.S. Air Force, U.S. Army, U.S. Coast Guard, U.S. Marine Corps, and U.S. Navy for their C-20 and C-37 fleets, over a 7-year period. Valued at $991 million, the contract includes global maintenance, component overhaul and repair, and modification services.

Gulfstream will perform the work at Joint Base Andrews in Maryland; Joint Base Pearl Harbor-Hickam in Hawaii; the U.S. Air Force's Ramstein Air Base in Germany; U.S. Marine Corps Base Hawaii at Kaneohe Bay, Oahu; and U.S. Naval Base Ventura County in California. To date, Gulfstream has delivered more than 200 special-mission aircraft to more than forty countries, including all branches of the U.S. military and key U.S. government agencies.

Lockheed Martin Infrared Sensors to Protect U.S. Navy Fighters

The U.S. Navy has declared Initial Operational Capability (IOC) status for a new infrared search-and-track (IRST) sensor system. The $108 million contract was initially awarded to Boeing in 2018, with Lockheed Martin as a subcontractor.

The system relies on the IRST21 long-wave infrared search-and-track sensor, which passively detects airborne targets well beyond visual range. IRST21 is integrated in the front of the centerline fuel tank.

Passive sensors such as the IRST21 enhance effectiveness and help assure mission survivability of legacy, fourth-generation fighter/attack aircraft, such as the F/A-18, in the increasingly lethal threat environment of contested airspace. Similar sensors also will equip U.S. Air Force F-15 C/D aircraft under a separate contract.

An EA-18G Growler conducts intercept training. (U.S. Navy photo by Mass Communication Specialist 1st Class Juan Sebastian Sua/Released, via DIVIDS.)

U.S. Navy Selects Raytheon's Next Generation Jammer Mid-Band System

RTX's Raytheon received a $590 million follow-on production contract from the U.S. Navy for the Next Generation Jammer Mid-Band (NGJ-MB) system for the EA-18G Growler, the electronic warfare variant of the F/A-18 Hornet aircraft. The result of a cooperative development and production program with the Royal Australian Air Force (RAAF), this contract includes delivery of shipsets, support equipment, spares, and non-recurring engineering support. The work will take place at four U.S. locations through 2028.

The NGJ-MB jammer can target advanced radar threats, communications, data links, and nontraditional radio frequency threats by reducing adversary targeting ranges and disrupting adversary kill chains. It enables flight crews to operate at extended ranges and attack multiple targets simultaneously using advanced techniques.

(Image courtesy of JetZero.)

U.S. Air Force Flies JetZero Small-Scale Blended-Wing Demonstrator

Tentatively named the "Pathfinder," a 23-foot wingspan, one-eighth-scale demonstrator is the first milestone in a $235 million U.S. Air Force contract awarded in 2023 to explore the blended-wing body (BWB) concept.

A BWB design shows promise for several military and commercial applications. Such an aircraft is expected to achieve reduced fuel consumption between 30 and 50 percent. The design also has an inherently low radar signature, lending itself to semi-stealthy defense tanker and cargo aircraft.

Following the successful test of a small-scale demonstrator in January, Northrop Grumman's Scaled Composites division has been fabricating a full-size airplane, with first flight testing scheduled for September 2027. In addition to the U.S. Air Force contract, it is estimated that at least a matching amount in private investment is funding the program. A future hydrogen propulsion system, offering zero carbon emissions, is being factored into the current design.

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An F-16D of the 416th Flight Test Squadron, 412 Test Wing, flying over Edwards Air Force Base, California. (U.S. Air Force photo by Todd Schannuth.)

L3Harris Completes First Flight Test for EW Suite

L3Harris announced the initial flight of a single-seat Block 70 F-16 outfitted with its new Viper Shield electronic warfare (EW) suite. Operated by the 412th Test Wing at Edwards Air Force Base in California, the flight included a series of risk reduction tests related to the mission computer and other avionic subsystems' compatibility, as well as interoperability with the APG-83 active electronically scanned array (AESA) fire control radar.

The Viper Shield system will provide advanced, low-cost EW capabilities to F-16 fleets for six international partners. Designed to counter modern radar threats with immediate detection and advanced jamming responses, this upgrade will integrate across all F-16 blocks with minimal modifications to the aircraft.

The new GE Aerospace T901 Improved Turbine Engines are part of Sikorsky's H-60M modernization efforts. (U.S. Army photo by Captain Kyle Abraham, 16th Combat Aviation Brigade.)

Sikorsky's Improved GE Engine for Blackhawks

Sikorsky begins the first ground runs of UH-60M Blackhawks outfitted with the GE Aerospace T901 Improved Turbine Engines (ITE). The company announced that in the test, which took place in Jan. 2025, the T901 engine demonstrated its capabilities through a series of rigorous procedures. The initial light off and ground runs were executed by a combined U.S. Army and industry test team and operated by U.S. Army and Sikorsky pilots at a Sikorsky facility in West Palm Beach Florida.

The U.S. Army selected General Electric Aviation in 2019 for a $517 million contract to complete engineering and manufacturing development work on its T901-GE-900 turbine engine for the service's Improved Turbine Engine Program (ITEP). The successful ground test enables advanced testing, including hover and forward flight tests, to proceed.

Hermeus Quarterhorse Mark 1 Completes Ground Tests

Hermeus is developing reusable hypersonic aircraft under a $60 million contract from the Pentagon's Defense Innovation Unit (DIU). Completion of the ground portion of the flight test program at Edwards Air Force Base in late 2024 was a key milestone for Hermeus's combined Quaterhorse/Darkhorse programs.

The successful integrated testing of all vehicle subsystems included the software and hardware in Hermeus' custom ground-based Flight Deck remote piloting control center. The development of the Quaterhorse program will directly contribute to the Darkhorse program and an uncrewed hypersonic aircraft designed to deliver unique, multi-mission, asymmetric capabilities to the U.S. military.

Stratolaunch Uses Boeing 747 to Launch Aerial Testbed

Stratolaunch announced in January that it will modify the Boeing 747 launch platform to launch its Talon-A vehicle, capable of flying at Mach 6, to aid in missile detection and defense programs. A hypersonic defense testing capability is essential in development of a multi-phased defense system to protect against ballistic missiles, hypersonic weapons, and advanced cruise missile threats.

Using Stratolaunch's 747 "Spirit of Mohave" will allow testing from any airport location capable of supporting this Boeing aircraft. The announcement came in January, with no contact amount disclosed.

Rolls-Royce Working on New Engine for Boeing B-52J

Rolls-Royce completed successful design review to proceed with initial development, testing, and production for its F130-200 engines. The program will pair the engine with new nacelles, pylons, and controls for the B-52J, with Boeing as the integrator of the project.

The overall B-52 upgrade also includes navigation, communications, and key structural improvements. This work is expected to extend the U.S. Air Force's B-52 fleet life to the 2050s.

The Rolls Royce F130-200 B-52 J re-engineering program will also include new nacelles, pylons, and controls. (U.S. Air Force photo by Master Sergeant Theodore Daigle.)

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This 2022 image was the first released rendering of BAE Systems's Concept 2 uncrewed aircraft, depicted in the foreground. (Image courtesy of BAE Systems.)

DEFENSE AIRCRAFT TECH — WHAT'S NEXT?

By Tracy Martin

Artificial intelligence (AI), automated co-pilots, unmanned collaborative aircraft, sixth-generation fighters, long-range bombers, stealthy transports and tankers, and enhanced early-warning and command support aircraft—all of these concepts and more will play a part in the future of aviation defense for the United States and other nations. Let's take a look at some of the most promising technologies to come.

ARTIFICIAL INTELLIGENCE AND UNMANNED PARTNERS

Future aircraft concepts under development will benefit from ongoing advances in artificial intelligence. The most common form of AI, as it is

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applied to military aircraft, is called Manned-Unmanned Teaming (MUM-T), involving what the U.S. Air Force describes as Collaborative Combat Aircraft (CCA). Both terms refer to AI-operated, unmanned aerial vehicles (UAVs) flying alongside bombers, fighters, tankers, transports, and other aircraft. In this configuration, those who strategically direct and fly manned aircraft can leverage MUM-T by using the capabilities of UAVs to enhance situational awareness and act as force-multipliers in operations in or near contested regions.

For instance, BAE Systems, "Concept 2" uncrewed aerial system, first revealed in 2022, is an autonomous collaborative platform that forms part of the company's vision for integrating uncrewed systems into future air combat operations. It includes a cost-effective, medium-sized UAV designed for aerial surveillance, reconnaissance, and other roles. In conversations at the 2024 World Defense Show in Riyadh, Saudi Arabia, Steve Reeves, head of business development and strategy platforms at BAE's FalconWorks technology accelerator, noted, "We have been carrying on our many decades of investment in uncrewed systems," and he explained how the

SUPPORTING GROUND FORCES

The Anduril Bolt-M unmanned aerial system delivers AI-enabled precision firepower. (Photo courtesy of Anduril Industries.)

In various roles, small drones have been changing modern warfare since 2015, when Russia and Ukraine began to use them to great effect for rapid targeting. In addition to assisting air combat operations, UAVs can provide key support for ground combat environments.

In this vein, defense products company Anduril Industries developed the Bolt-M, an autonomous VTOL aircraft that delivers simple and flexible capabilities for a range of missions. In late 2024, Anduril was awarded a $250 million dollar production contract by the U.S. Department of Defense to further develop and deliver such air defense capabilities across the nation's armed forces.

The munition variant of the Bolt platform is designed to arm ground forces with lethal precision firepower, leveraging Anduril's Lattice software platform, onboard AI, and machine learning (ML) software to automate the flight behaviors required to find, track, and strike dynamic targets. With autonomous waypoint navigation that can be modified as needed through a touchscreen interface, the system provides human operators with four simple decisions: 1) where to look, 2) what to follow, 3) how to engage, and 4) when to strike.

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SIXTH-GENERATION ATTRIBUTES

While so many details about the next generation of aircraft remain classified, expected characteristics include:

Advanced Connectivity: Sixth-generation systems will form a networked ecosystem, linking aircraft, ground stations, naval commands, and satellites, enabling cooperative engagement and real-time data sharing.

AI-Driven Decision Making: Artificial intelligence and machine learning will assist pilots in data processing during standard flight maneuvers and high-stress scenarios, facilitating situational focus and fast, accurate decision-making.

Cutting-Edge Stealth: New radar-absorbent materials and other improvements increasingly will minimize the operational acoustic, electronic, and thermal signatures of defense aircraft.

Versatility: Equipped with long-range sensors, agile avionics suites, and state-of-the-art weaponry, new aircraft will support a broad range of missions, from reconnaissance and electronic warfare to strike operations.

An artist's rendition of a Boeing sixth-generation fighter. (Image courtesy of Boeing.)

Boeing's sixth-generation fighter concept. (Image courtesy of Boeing.)

concept has evolved into a more optimized design. The same can be said for similar initiatives underway around the world.

Another way that AI can effectively serve defense aviation is taking on the role of a virtual copilot or other crew member and assist air crews by automating and reducing in-flight workloads. For example, using AI to prioritize incoming data and handle routine cockpit functions can free up human pilots to concentrate on critical tactical decision-making.

While data processing has long been central to analytics valued by maintainers, its complexity and the potential for automation also is on the rise. Both inside and outside military aircraft, AI is fueling ever more efficient diagnostic and predictive maintenance systems.

THE NEXT GENERATION OF TACTICAL AIRCRAFT

The United States, European nations, and Japan are all advancing programs to develop sixth-generation combat aircraft for deployment in the 2030s. These initiatives include the U.S. Air Force's Next Generation Air Dominance (NGAD) system; the U.S. Navy's F/A-XX NGAD; Europe's Future Combat Air System (FCAS) involving France, Germany, and Spain; and the Global Combat Air Program (GCAP) spearheaded by Italy, Japan, and the United Kingdom. At the core of these programs is a "system-of-systems" approach that integrates manned fighter jets and other aircraft, unmanned tactical aircraft, and communication and control centers to maximize operational interoperability.

With sixth-generation aircraft development still in its early stages and not likely to fully mature until the 2040s, discussions about seventh-generation systems already have begun. As nations race to define the next era of air dominance with autonomous combat aircraft playing

...using AI to prioritize incoming data and handle routine cockpit functions can free up human pilots to concentrate on critical tactical decision-making.

The manned New Generation Fighter, supported here by three unmanned remote carrier escorts, will form the heart of Europe's Future Combat Air System (FCAS). (Image courtesy of Airbus.)

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A B-21 Raider conducting flight testing at Edwards Air Force Base, California. (Photo by Giancarlo Casem, 412th Test Wing, courtesy of the U.S. Air Force.)

This carefully staged photo of the B-21 Raider is intended to impress, while denying adversaries significant insights. (Photo by Staff Sergeant Jeremy Mosier, courtesy of the U.S. Air Force.)

an ever-increasing role, the evolution of interactive aviation defense systems may be paving the way for a primarily or even entirely unmanned future. The term "seventh-generation," in reference to manned aircraft, could even become obsolete, as AI and UAVs continue to evolve.

LONG-RANGE BOMBERS

The U.S. Air Force is ushering in the Northrop Grumman's B-21 Raider as its highly anticipated sixth-generation bomber, set to replace the legacy B-1B and B-2A models. The B-21's integration of data, sensors, and weapons, along with its state-of-the-art stealth technology, adaptability, and other capabilities, are expected to make this new model a cornerstone of modern aerial warfare.

Reportedly, this highly survivable aircraft will have the range and payload capacity to perform even in remote, heavily contested environments. The bomber's open-architecture design also will enable it to take advantage of rapid upgrades, ensuring its technological advantages remain ahead of evolving threats.

"The current goal of 100 aircraft takes us from procurement into the late 2030s."

In late 2023, following the first flight of a test aircraft, Northrop Grumman was awarded a Low-Rate Initial Production (LRIP) order. The B-21 has been undergoing additional flight testing at Edwards Air Force Base, California, but precautions have been taken to limit visual exposure of the aircraft's configuration to keep adversaries from analyzing its design. While the first official photos were released during flight testing in May 2024, these images were strategically captured from specific angles, presumably to obscure detailed features.

In terms of cost and schedule, the B-21 Raider procurement program remains shrouded in uncertainty. While unit costs have been estimated at approximately $500 million per aircraft, official figures have not yet been disclosed. Precise production rates and timelines also have yet to be made public, with only broad outlines available to date.

According to William LaPlante, Undersecretary of Defense for Acquisition and Sustainment, "The B-21 is expected to enter service in the mid-2020s, with a production goal of a minimum of 100 aircraft." During his March 2024 testimony before the House Armed Services Committee, Lieutenant General Richard Moore, Jr., U.S. Air Force Deputy Chief of Staff for Plans and Programs, predicted, "The current goal of 100 aircraft takes us from procurement into the late 2030s."

Moore went on to say, "A decision point regarding procurement beyond 100 units would be somewhere in the mid- to late 2030s." Considering that by that time U.S. defense planners will be evaluating alternate bomber designs with added capabilities, the end result could be a mixed fleet of B-21 Raiders and one or more new platforms serving through the mid-century.

STEALTHIER TANKER AND TRANSPORT SUPPORT

The U.S. Air Force's Air Mobility Command (AMC) is planning significant modernization efforts for its transport and tanker fleets to ensure well-balanced and mutually supportive

In this illustration, a group of UAVs escorts support a Next Generation Air Dominance (NGAD) aircraft that resembles the B-21 bomber. (Photo by Greg Davis, courtesy of the U.S. Air Force.)

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▲ JetZero's blended-wing air mobility concept could be configured as a tanker or airlifter. (Image courtesy of JetZero.)

▶ A rendering of JetZero's blended-wing body concept configured as a tanker, with a F-35A Joint Strike Fighter receiving fuel. (Image courtesy of JetZero.)

◀ This recent illustration shows a potential Next Generation Air Refueling System (NGAS). (Image courtesy of Lockheed Martin.)

platforms. General Michael Minihan, commander of the AMC, highlights the importance of integrating various aircraft and weapons systems in future operations. In a statement last year, he emphasized, "Integration needed at the higher level needs to be addressed aggressively," adding that combat and mobility aircraft must be developed together "as a system."

Although stealth technology is typically associated with combat aircraft, future tanker and transport designs are likely to incorporate varying signature-reduction features to improve their survivability in contested airspace. Though only a portion of fleets will require the highest levels of radar signature reduction, as many airlift missions still will take place in safer environments or mid-threat-level areas.

Tankers, in particular, are likely to benefit from reduced radar signatures, facilitating their accompanying or trailing combat aircraft in deep-penetration missions into hostile environments. As Minihan explains, "We've got to have a fleet that can go into the high weapons engagement zone that has an enormous amount of risk."

In February 2023, the U.S. Air Force issued a Request for Information (RFI) for the Next Generation Aerial Refueling System (NGAS), with the goal of developing a more survivable tanker by 2040. While the RFI avoided using terms like "stealth," it did emphasize the need for an aircraft capable of operating effectively amid peer or near-peer conflicts.

As noted by U.S. Air Force Assistant Secretary for Acquisition, Technology, and Logistics Andrew Hunter, "It must be able to survive and operate in a much more contested environment than the tankers of the past or the tankers that are in our current fleet." He added that the Air Force wants tankers that can "go deeper into contested airspace, have more advanced self-protection capabilities and more advanced networking capabilities."

The envisioned operational NGAS concept involves an aerial tanker refueling in uncontested airspace, accompanying fighters or bombers into contested zones, and providing mid-mission refueling as combat aircraft approach their targets. Afterward, the tanker would return to safer airspace, rendezvous with a larger tanker to replenish its fuel supply, and head back to support returning combat aircraft.

Both Boeing and Lockheed Martin are actively developing NGAS concepts. Lockheed Martin has unveiled transport designs showcasing such features as lambda-shaped wings and recessed engine air inlets designed to reduce detectability.

TOMORROW'S TRANSPORTS

Alongside the Next Generation Aerial Refueling System (NGAS), the U.S. Air Force is advancing the Next Generation Airlift (NGAL) program, envisioned as a family of transports with differing sizes and performance profiles. This initiative could add to or replace C-17s and C-130s, while introducing smaller, more versatile platforms. According to the U.S. Air Mobility Command (AMC), these next-generation and "generation-after-next" transport aircraft will feature revolutionary designs and capabilities. Key technologies under consideration include unmanned operations and vertical takeoff and lift (VTOL) capabilities.

As part of the NGAL effort, the U.S. Air Force has shown strong interest in blended-wing body (BWB) designs that integrate the fuselage and wings. Enhancing lift, these designs can improve fuel efficiency, add range, and increase speed as compared to traditional tube-and-wing airframes. And while not inherently stealthy, the integrated form may achieve a reduced radar cross-section, depending on engine placement and configuration.

BWB models are expected to retain a comparatively large onboard space, which could accommodate new hardware and personnel without compromising the ability to perform primary missions. Cargo could include palletized weapons such as cruise missiles, updated communications relays, and expanded datalinks to enhance command and control.

In August 2023, the U.S. Air Force awarded California-based JetZero a contract to develop a large BWB demonstrator capable of fulfilling either cargo or tanker roles. Flight testing

Enhancing lift, these designs can improve fuel efficiency, add range, and increase speed as compared to traditional tube-and-wing airframes.

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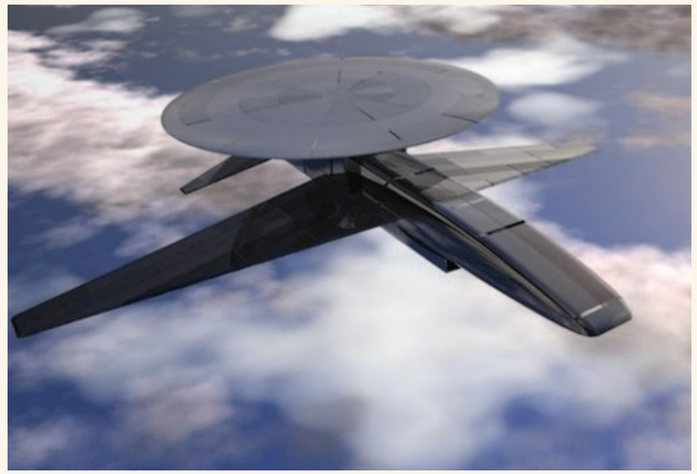
COMBINING EARLY WARNING AND COMMAND SUPPORT



This artist's concept shows an airborne early warning (EW) aircraft that could use active electronically scanned array (AESA) radar and feature long- and short-range self-defense air-to-air missiles stored in aerodynamic pods. (Image courtesy of the Australian Defence Force.)

The airborne early warning and control (AEW&C) E-7 Wedgetail. With the possibility of sixth-generation fighters having EW capabilities, it is uncertain whether dedicated, stealth EW platforms will be developed. (Photo courtesy of Boeing.)

Planned replacement programs for early warning (EW), surveillance and targeting aircraft, and airborne early warning and command (AEW&C) platforms rely on modified commercial aircraft designs. Will these designs effectively assist combat and air mobility units operating within contested airspace?

Traditionally, support aircraft were kept at a safe distance from conflict zones, but this strategy is becoming less viable, as adversaries deploy extremely long-range and potentially hypersonic air defense systems. Developing clean-sheet stealth designs for a small fleet of specialized platforms is cost-prohibitive, prompting exploration of new solutions.

To spread vital functions across multiple platforms, two complementary approaches are gaining traction:

First, discussions around sixth-generation air dominance systems suggest integrating EW, reconnaissance, targeting, and command-and-communications functions into unmanned escort aircraft.

Second, while sixth-generation platforms are already expected to feature significantly enhanced EW capabilities, stealth-configured EW air mobility platforms could be adapted for support missions, offering another layer of operational flexibility.

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A next generation stealth tanker concept. (Image courtesy of Lockheed Martin.)

should begin by 2027, with JetZero aiming for production readiness by 2030.

Boeing also has unveiled a conceptual BWB tactical transport with improved low-observability characteristics. While still in early development, the manufacturer estimates this aircraft could be operational by the mid-to-late 2030s.

Similarly, Airbus has presented a BWB concept with an estimated operational range of about 2,300 miles. Although initially designed for civilian use, this platform could be adapted for military airlift and mobility missions.

FULL STEAM AHEAD—OR NOT?

Conceivably, unrealistic technological demands and budgetary constraints could put the brakes on any new concept or project, regardless how promising. Over the last 20 years, cutting-edge projects have been cancelled or delayed because of immature technologies, designs that under-performed, the tendency of defense planners to request design changes once construction is underway, and even global supply chain shortages. Thus, considering the level of innovations and performance expectations for next-generation aircraft, it would be wise to approach predictions of production and deployment timelines with caution.

From a budgetary perspective, the proposed manned aircraft are expected to be significantly more expensive than their legacy counterparts. This is especially true for combat aircraft, where achieving extreme performance improvements will come at a high cost. For example, the U.S. Air Force's manned NGAD fighter could cost upward of $300 million per aircraft, triple the price of the F-35.

It seems unlikely at this juncture that legislatures in the United States and other nations will entirely cancel sixth-generation aircraft programs. Nevertheless, there is a genuine risk that they may impose procurement limits below levels deemed essential by their respective armed forces. The growing capabilities of unmanned aircraft, particularly those designed as integral components of sixth-generation system-of-systems, may offer budget-conscious legislators' added justification for minimal acquisition of the most advanced manned models.

Undoubtedly, some variants of sixth-generation aircraft and their associated technologies will find their way into the arsenals of the United States and its allies. While adversaries will also pursue new aircraft, their more limited resources may leave them struggling to keep pace. The key will be to invest sufficiently and strategically to continue maintaining a decisive edge.

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THE GLOBEMASTER

This Veteran Cargo Plane Just Keeps Getting Better
By Donna J. Kelly

The Boeing C-17 Globemaster III is truly an international player, serving an amazingly diverse collection of operators within an equally diverse set of conditions. As this highly esteemed workhorse enters its third decade of service, the demand for upgrades and sustainment, parts and spares, support team and air crew training, and even self-protection, keeps inventive engineers, key suppliers, and vital maintainers occupied, as they strive to make the Globemaster even better.

The cargo giant is powered by four Pratt & Whitney F117-PW-1 engines, which have benefited from continuous improvements since being installed on the first C-17s in 1991. In July 2023, a $5.5 billion contract was awarded by the U.S. Air Force to Pratt & Whitney (a division of aerospace conglomerate RTX of Arlington, Virginia) for F117 engine sustainment support, covering both current and future modifications through 2027.

According to Chris Johnson, Vice President of Fighter and Mobility Programs at Pratt & Whitney, "One specific product improvement we are looking to incorporate under this contract is a compressor blade coating technology, which can extend time on wing by up to 16 percent and reduce fuel burn by over 1 percent. If we can improve durability for the [U.S.] Air Force, while lessening impact on the environment, then that is a win-win."

The global fleet of Globemasters, flown by the U.S. Air Force and its eight international partners, is scheduled to receive the planned modifications. Work has begun at Tinker Air Force Base, Oklahoma, and is scheduled to be completed by mid-2027. Upgrades also will be performed at other Pratt & Whitney locations, including Columbus, Georgia, and San Francisco, California.

A C-17 Globemaster III, stationed at March Air Reserve Base, Calif., performs a reverse thrust maneuver for training at Vandenberg Air Force Base, CA. A thin water vapor vortex appears on the far left engine. (U.S. Air Force photo/Staff Sgt. Levi Riendeau)

The U.S. Air Force made a $5.5 billion addition to an existing deal with Pratt & Whitney, a subsidiary of RTX , for the sustainment of F-117 aircraft engines. (Image courtesy of Pratt & Whitney.)

INSPECTING HARD-TO-REACH PLACES

Hardworking aircraft like the C-17 require constant vigilance to detect otherwise unseeable damage, defects, or weakness in structural integrity. As the Globemaster stands 55 feet 1 inch high, conducting a thorough inspection of its tail section is challenging to say the least.

An efficient solution is replacing live inspectors perched precariously in high lift buckets with small inspection drones made by Skydio of San Mateo, California. Each drone is equipped with an onboard 64-megapixel, high-resolution forward-looking infrared (FLIR) camera made by Teledyne of Thousand Oaks, California. The drones not only take high-resolution pictures, they also use their own artificial intelligence (AI)–based software algorithms to quickly detect and analyze the images they collect. The AI program identifies any deviation, including small chips or other anomalies in the surface paint, unprotected or popped screws and rivets, missing seam seals, exposed composite fibers, and more.

To test the efficiency and accuracy of the new process, an analysis was done in 2023 of more than 4,000

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THE HUMAN ELEMENT

The 911th Maintenance Squadron at the Pittsburgh International Airport Air Reserve Station, Pennsylvania, uses a small drone to conduct inspections of hard-to-reach parts of a Globemaster. (U.S. Air Force photo by Joshua J. Seybert.)

Operating sophisticated drones for any purpose presents its own set of challenges. In late January 2025, the first official in-house drone training was conducted for operators of small unmanned aerial systems (UAS) used in aircraft maintenance. Over the course of the 5-day training, students learned and practiced thirty-two drone flight training objectives, focusing on competency and flight safety, as well as the fundamental rules for flying on an active airfield.

Applying what they had learned in the classroom to a real-world scenario prepares these maintainers for efficiently carrying out their on-the-job duties. "Being able to use the drone has increased my confidence in my own personal safety," says Senior Airman Mathew Closas, 860th Aircraft Maintenance Squadron airlift/special mission aircraft maintenance specialist. "This allows me to focus solely on the inspection."

"Setting up the program required navigating complex regulations and overcoming significant challenges to qualify Travis airmen to use drones for remote aircraft inspection," explains U.S. Air Force Chief Master Sergeant Max Dombroski, 60th MXG. "It really is a big step forward." Skydio's CEO and co-founder Adam Bry believes that expanded use of the inspection drones can save the military a lot of money. He recently recommended that the U.S. government should "scale up the use of small drones for military aircraft inspection. Extrapolating their math gets you $15 million per year. Plus, it's super cool and also keeps the human inspectors safer."

The X-51A Waverider, shown here under the wing of a B-52 Stratofortress, is set to demonstrate hypersonic flight. Powered by a Pratt & Whitney Rocketdyne SJY61 scramjet engine, the missile is designed to ride on its own shockwave and accelerate to about Mach 6. (Image courtesy of the U.S. Air Force.)

images. The results showed that since the introduction of the advanced camera combined with the anomaly detection software, inspection times have been cut in half. The system also achieved a 93 percent true positive detection rate, far better than the rate achieved by human inspectors.

In summary, these mini-machines complete the same inspection job faster, with no bodily risk to maintainers, improve on accuracy, and thus better support proactive maintenance measures. All of this contributes to a reduction in aircraft downtime and sustainment costs.

LIGHTNING-FAST PROTECTION

The Boeing Company, in collaboration with the U.S. Air Force Research Laboratory, the U.S. Defense Advanced Research Projects Agency (DARPA), and Pratt & Whitney Rocketdyne of Canoga Park, Los Angeles, California, has developed a new defense system for C-17s under attack. The aircraft will soon be able to fight back by launching Boeing X-51A Waverider hypersonic missiles.

The Waverider missiles are mounted inside the aircraft and placed in an advanced electromagnetic catapult mechanism, nicknamed the "Revolver." This device consists of two loaded drums, each capable of dispensing up to twelve X-51A cruise missiles.

The missiles, which weigh about 4,000 pounds each, are catapulted from the cargo compartment of the Globemaster, with their exhaust section leaving the aircraft first. Once clear of the airframe, a rocket ignites to propel the missile up to a speed close to Mach 5.

At this stage, the Waverider's scramjet comes online and begins to burn JP-7 jet fuel, pushing the weapon beyond Mach 6, or more than six times the speed of sound. Pratt & Whitney Aerospace of East Hartford, Connecticut, developed the Rocketdyne SJX61 engine. Originally intended for the U.S. Air Force Research Laboratory's (AFRL) Hypersonic Propulsion program, this remarkable, state-of-the-art engine provides the thrust needed to get the weapon to its target fast.

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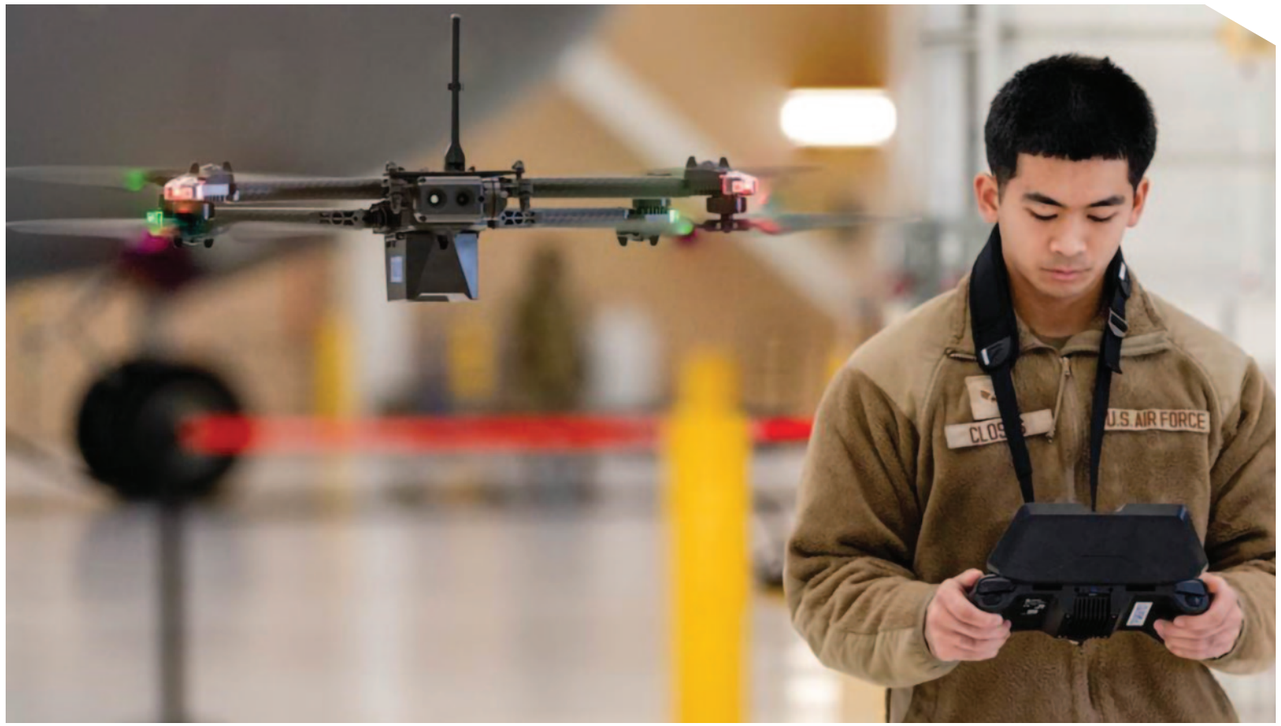

U.S. Air Force Senior Airman Mathew Closas, 860th Aircraft Maintenance Squadron airlift/special mission aircraft maintenance specialist, flies a drone in a hangar at Travis Air Force Base, California, January 30, 2025. (U.S. Air Force photo illustration by Gary M. Edwards Jr.)

CONTRACTS IN THE WORKS FOR GLOBEMASTER WORK

In October 2024, the government of the United Arab Emirates (UAE), awarded Boeing a $980.4 million contract for a C-17 Global Enhancement upgrade package that includes advancements in integrated software and hardware, test studies focusing on quick-reaction tasks, ongoing support and sustainment, personnel training, and more. Since the Globemaster is an American-made aircraft, most upgrades are performed in the United States, with these particular modifications being done at Edwards Air Force Base, California. A stateside location allows for optimal performance, compatibility with U.S. systems, and easily accessible reference data and tools. Completion of the project is expected by December 2031.

Also in late 2024, Boeing was awarded a cost-plus-fixed-fee contract valued at up to $51.33 million for the procurement and delivery of kits and spare parts to

A U.S. Air Force service member conducts preflight checks on a C-17 Globemaster III at Joint Base Lewis-McChord, Washington, January 8, 2025. (U.S. Air Force photo by Senior Airman Elizabeth Schoubroek.)

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Two U.S. presidential limousines are loaded onto a C-17 for transport for the commander-in-chief once he arrives at his destination. These expensive bulletproof Cadillacs, individually dubbed "The Beast," are stocked with a supply of blood matching the president's type, as well as an oxygen supply in case of chemical attacks. (Image courtesy of and © U.S. Secret Service.)

U.S. Air Force Airman 1st Class Alexandra Shaddow, a loadmaster in the 3rd Airlift Squadron, Dover, Delaware, motions to lower the ramp of a C-17 Globemaster III, during combat offload Method C testing in January 2024. (U.S. Air Force photo by Airman 1st Class Amanda Jett.)

Aircrew members position vertically stacked cargo onto the bay of a C-17 Globemaster III at Ellsworth Air Force Base, South Dakota, in February 2024. Application of this new method of vertical pallet stacking helps maximize cargo space. (U.S. Air Force photo by Airman 1st Class Dylan Maher.)

A C-17 Globemaster III assigned to the 62d Airlift Wing prepares to take off from Phoenix Airfield, Antarctica, in October 2024. The wing's commitment to supporting the Antarctic airlift mission of Operation Deep Freeze spans an impressive 26 years. (U.S. Air Force photo by Senior Airman Colleen Anthony.)

retrofit and sustain the heads-up display systems of C-17s. In addition to aircraft operated by the U.S. Air Force, these benefits also will be enjoyed by the countries that received this transport through the Foreign Military Sales (FMS) program, including Australia, Canada, India, Kuwait, Qatar, the United Arab Emirates, the United Kingdom, and the North Atlantic Treaty Organization (NATO) Airlift Management Programme.

At the same time, due to financial problems not associated with the highly successful Globemaster, Boeing has been cutting jobs, particularly in the Southern California area. This includes their Long Beach location, where the C-17 upgrade work is scheduled to be completed. Many of the job cuts reportedly include engineers, system analysts, technical designers, and project specialists.

We spoke to Deborah VanNierop, Senior Media Relations Manager, at Boeing Defense, Space & Security, about the impact these job losses will have on the aerospace giant's ability to complete the contracted work done in the agreed upon time. VanNierop replied, "We are currently executing the C-17 Globemaster III landing gear spares management services contract in accordance with established requirements." She assured that "the C-17 Globemaster III sustainment contract will not be disrupted (by recent workforce activity). Our Global Services team is positioned to meet the needs of our U.S. Air Force and global customers."

INNOVATIONS IN CARGO HANDLING

The U.S. Air Force strongly encourages its airmen to devise new methods and processes to save both time and money and increase safety. Innovation comes from many sources, and significant advances are being achieved by teams in the field.

For example, in January 2024, the newest technique for unloading cargo, called "Method C," was first successfully tested by the 3rd Airlift Squadron at Dover Air Force Base, Delaware. In this method, pallets of freight inside the aircraft are placed on a loading rack, locked into the internal rail system, and finally attached to a winch. The ramp is then lowered and angled to a height of 12 inches above the ground. The winch slowly pulls the pallet towards the end of the loading ramp, where it is gently lowered onto the ground.

This unloading method involves zero ground equipment, forklifts, or other external loading platforms, so it can be used just about anywhere. Plus, the drop height is lower than the standard drop height, reducing damage to sensitive equipment or supplies, a crucial concern for military operations. It also increases cargo handling efficiency, which really matters when a C-17 operates in dangerous places and needs to get in and out safely.

Another new method was recently employed by the 28th Logistics Readiness Squadron of Ellsworth Air Force Base, South Dakota. Using a newly designed Vertical Pallet Stacker (VPS), loaders found that they could load more cargo and streamline the process overall. The VPS aluminum frame permits stacking pallets on top of one another, freeing up space for a bigger payload—as much as an extra 3,000 pounds of cargo per pallet space.

While only a small number of C-17 operators have this technology today, the U.S. Air Force plans to create forty VPS frames at a cost of $27,000 each. Construction plans also are being made openly available, so that squadrons can fabricate their own VPS. Analysts say that use of the frame can save more than $16,000 per sortie.

Technical Sargeant Brett Kiser, assigned to the 379th Air Expeditionary Wing (AEW) at Al Udeid Air Base, Qatar, noticed that the loading of munitions pallets often caused major damage to the aircraft cargo rail and fuselage, resulting in extra maintenance and mission delays. To correct this, Kiser devised a tool that can be temporarily installed to smoothly guide the pallets into the aircraft on the intended path.

The part became known as the "K-Wedge," and Sargeant Kiser says its success is due to the robust structural integrity that enables it to withstand the brute force of heavy ammo pallets during loading operations. Kiser and his team won second place in a service-wide competition in 2020 that promoted their invention to the highest levels of U.S. Air Force leadership. Today, Senior Master Sergeant Kiser serves as the Senior Enlisted Leader for the U.S. Air Force Strategic Studies Group.

This all led to an extensive trial period of testing conducted by the Heavy Airlift Wing (HAWS), based at Pápa Air Base in Hungary. (HAWS is a multinational airlift wing that provides strategic airlift capabilities to twelve NATO and partner nations.) Boeing provided engineering support, and Bunker Supply of Santa Barbara, California, developed the modernized prototype using state-of-the-art-tooling.

STILL STRONG, STILL SUPPORTED

The Globemaster has served honorably and reliably for more than three decades, and the often-requested cargo plane is still receiving its fair share of upgrades, modifications, and role-extending advancements. It is good to know that the C-17 will be around for a while, highly appreciated and well supported.

AAD

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Kuwait, Oman, Qatar, and Saudia Arabia all count the Typhoon as an important part of their air force fleets. (Image courtesy of Eurofighter.)

EUROPE'S FIGHTER JET

Can the Eurofighter Typhoon Stay Relevant in the Age of Stealth Fighters?
By Jeff Blundell

For a decade, we heard about how the F-35 would push aside the F-16 to become the world's dominant air superiority fighter. Instead, what has happened is that both of these capable aircraft have found a role in the defense aviation hierarchy and will remain in the fleets of the U.S. armed forces and allied militaries for decades to come.

But what about another important fighter plane of this era? What will become of the Eurofighter Typhoon? Can it also retain a role within North American Treaty Organization (NATO) nations?

Four Typhoons fly in formation over the British countryside. (Image courtesy of Eurofighter.)

A BRIEF HISTORY LESSON

In 1986, Airbus, BAE Systems, and Leonardo formed the joint holding company *Eurofighter Jagdflugzeug GmbH*, which roughly translates as the Eurofighter Fighter Aircraft Company with Limited Liability. The group designed the Typhoon to serve as an air superiority fighter for western European militaries.

Their production plan was truly unique. Each of the four founding countries—Germany, Italy, Spain, and the United Kingdom—was allocated production responsibilities, according to the number of planes they purchased. For example, since Great Britain was buying 232 planes, (37 percent of the total production) 37 percent of the work was to be done by BAE Systems.

The group designed the Typhoon to serve as an air superiority fighter for western European militaries.

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Four Typhoons, one from each of the core nations — Germany, Italy, Spain, and the United Kingdom — fly in formation. (Image courtesy of the Spanish Air Force/Eurofighter.)

EUROFIGHTER TYPHOON SPECIFICATIONS

Manufacturer:
Eurofighter Jagdflugzeug GmbH
First flight:
March 27, 1994, in Munich, Germany
Officially began operations:
2003
Currently in service:
572 airplanes
Engines:
Two Eurojet EJ200 afterburning turbofans
Length:
52 feet 4.25 inches (15.96 meters)
Wingspan:
36 feet 4.5 inches (11.09 meters)
Weight (empty):
22,000 pounds (10,000 kilograms)
Maximum take-off weight:
51,800 pounds (23,500 kilograms)
Maximum altitude:
55,000 feet (16,765 meters)
Maximum speed:
Mach 2+ (1,550+ mph)
Range:
1,800 miles (2,900 kilometers)

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The Typhoon boasts exceptional speed and maneuverability, thanks to a combination of advanced aerodynamics and powerful engines. (Image courtesy of Geoffrey Lee/Eurofighter.)

This was politically appealing as it kept defense spending on the aircraft in country.

The Typhoon entered operational service in 2003, and roughly 600 have been built. Today, it is flown primarily by the United Kingdom's Royal Air Force, as well as the Austrian, German, Italian, and Spanish militaries. Kuwait, Oman, Qatar, and Saudi Arabia also have Typhoons in their inventory.

This twin-engine, supersonic fighter jet boasts an instantly recognizable shape. Its distinctive, aggressive form is tailored for high-speed maneuverability and agility, and its short, delta-shaped wings end in sharp, forward-swept edges. But its most distinctive features are its canards: smaller wings positioned in front of the main wings that help with the aircraft's stability and control during maneuvers, especially at high angles of attack. Featuring a fly-by-wire control system, the model is available in both single- and twin-seat variants.

Typhoons first saw combat in 2011, when Italy and the United Kingdom deployed the fighters for both aerial reconnaissance and ground-strike missions in Libya, where their main purpose was to enforce the no-fly zone against Muammar Gaddafi's forces. Otherwise, the Typhoon has been used primarily for air defense duties. Most recently, there have been rumblings that the U.K. Royal Air Force could deploy them in Ukraine as part of a peacekeeping force, but at the time of this writing that was yet to be determined.

MORE AGILE FIGHTERS FOR ITALY

In December 2024, Italy announced its acquisition of twenty-four brand-new aircraft. "The Eurofighter Typhoon is a cornerstone of the *Aeronautica Militare* (*AM*; the Italian Air Force), serving as its principal air

Two EJ200 engines, each providing 20,000 pounds of thrust, give the Typhoon a top speed of more than Mach 2. (Image courtesy of Geoffrey Lee/Eurofighter.)

The Typhoon is instantly recognizable in the sky, due to its delta wing design and distinctive canards. (Image courtesy of Geoffrey Lee/Eurofighter.)

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Oman is one of four countries in the Middle East that flies the Eurofighter Typhoon. (Image courtesy of Eurofighter.)

A trio of Italian jets patrol the region around Iceland. (Image courtesy of the Italian Air Force/Eurofighter.)

Italy currently has ninety-three Typhoons in service, with twenty-four more on order. (Image courtesy of the Italian Air Force/Eurofighter.)

defense platform," says General Diego Filippo of the AM. "Its speed, maneuverability, and advanced weapon systems make it ideally suited for this critical role."

Flexibility is a buzz word often used to describe the appeal of the Typhoon. According to Filippo, "We have strategically developed what we call 'swing-role' capabilities for the Typhoon. This allows the aircraft to seamlessly transition between different mission profiles during a single sortie. Leveraging its ground attack capabilities, the Typhoon can effectively perform close air support for ground forces and strike high-value targets deep within enemy territory. Meanwhile its agility, supersonic speed, and sophisticated weapon systems, including advanced air-to-air missiles, ensure its dominance in air superiority scenarios." He continues, "This multirole flexibility makes the Typhoon a highly adaptable asset in modern warfare, capable of responding to a wide range of threats and mission requirements."

Filippo also points to the fact that their Typhoons carry a diverse array of weaponry. The Italian Air Force equips its jets with air-to-air missiles, such as the Meteor, a European active radar guided beyond-visual-range air-to-air missile (BVRAAM), and the American-made AIM-120 advanced medium-range air-to-air missile (AMRAAM), as well as air-to-ground munitions, such as the Paveway series.

"The Eurofighter Typhoon is a pinnacle of modern multirole fighter jet design. Its exceptional speed and maneuverability, derived from a combination of advanced aerodynamics and powerful EJ200 engines, provide a decisive edge in air-to-air engagements. This agility allows pilots to outmaneuver adversaries, a critical capability for maintaining air superiority," concludes Filippo.

Decisions on acquisitions like Italy's are made by the individual nations. But clearly NATO has some influence, or at least an opinion.

"The Eurofighter, F-16, and F-35 aircrafts complement one another," commented a NATO official we spoke with. "The future of NATO's air power depends on a mix of interoperable platforms embedded in a resilient structure that ensure we are ready to implement a variety of different operational scenarios.

A pair of Austrian Typhoons on patrol. Austria currently has fifteen jets in operation. (Image courtesy of Geoffrey Lee/Eurofighter.)

The EJ200 engine is smaller and simpler than many comparable powerplants. It is largely based on the Rolls Royce XG-40, which was developed in the 1980s. (Image courtesy of Jaden Shillingford/Eurofighter.)

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▲ Hensoldt and its partners are continually designing and upgrading radar systems for the Typhoon fleet. (Image courtesy of Eurofighter.)

◀ Hensoldt holds the contract for maintaining most of NATO's Typhoon fighter jets, with operational facilities in Germany, Italy, Spain, and the United Kingdom. (Image courtesy of Eurofighter.)

Italy's procurement of twenty-four new Typhoons strengthens national security but also the collective defense of the [North Atlantic] Alliance, meeting NATO's broader goals of maintaining a modern, high-readiness force capable of countering current and future threats."

REACTING TO RUSSIA

Another reason the Typhoon is holding its own as the first option for European air forces is geo-political priorities. While the U.S. military may be hyper-focused on how a conflict with China would play out, its NATO allies in Europe are eyeing a different adversary.

"The most important aerial activity for European NATO members is air policing of their borders to ensure sovereignty from the Russians," asserts Brent M. Eastwood, a journalist and defense insider with a long history of following NATO aviation defense forces in Europe.

"The Eurofighter Typhoon is great for air policing and making sure Russia does not encroach on a country's air defense identification zone (ADIZ). All NATO members, especially those on Russian borders, should make sure they can scramble fighters in quick reaction to intercept adversarial airplanes flying into their ADIZs. The Typhoon, and other jets like it, are great for this defensive role. Its great rate of climb and ceiling make it a valuable warbird to make sure adversaries stay out of ADIZs."

Despite being bullish on the Typhoon's value, Eastwood is cognizant of its major drawback when compared to fifth-generation fighters. "It has limited stealth attributes," concedes Eastwood. "But they've done a few things to reduce its radar cross section."

The jet inlets hide the front of the engines, which are a strong radar target. The wing, canard, and fin leading edges are swept to avoid reflecting radar energy to the front of the airframe, and some of the external weapons are mounted semi-recessed into the airframe. Plus, radar-absorbent materials are used on many reflector spots.

Still, even the Typhoon's most ardent supporters will not claim this

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▲ Despite its being a fourth-generation fighter and lacking modern stealth technology, the sun has not yet set on the operational life of the Eurofighter Typhoon. (Image courtesy of Gaz West/Eurofighter.)

plane is designed to sneak into enemy air space undetected. "I see it more as a defensive fighter. So, I'm not as concerned with the lack of complete stealthiness," says Eastwood.

COLLABORATING WITH ALLIES

Increasingly, large military operations involve multiple nations working in concert. That can be challenging when each organization is using different equipment.

"Fielding a diverse range of assets within NATO air forces certainly presents challenges," says General Filippo. "But while differences in data links, communication systems, maintenance, logistics, and operational procedures can cause issues, the benefits of this diversity ultimately outweigh the difficulties."

He explains, "Standardization is the key to maximizing the effectiveness of this diverse force. NATO allies have significantly increased joint training exercises, refining standard operating procedures and fostering information sharing between air forces. The ability to operate seamlessly with different assets is constantly honed through numerous combined exercises and operations."

"The focus is always on extracting the best performance from each nation's systems and assets, leveraging their unique capabilities to create a more robust and effective collective defense," Filippo points out. "This collaborative approach ensures that the sum of the parts is greater than the whole."

"I see it more as a defensive fighter. So, I'm not as concerned with the lack of complete stealthiness."

KEY TO THE FUTURE: STAYING COMPETITIVE

Ultimately, the decision about how long the Typhoon remains in active service will be made, at least in part, by economics. One such consideration is the desire amongst European nations to support and expand their military industrial base. This means keeping government contracts and the jobs they create at home in Europe. And that includes maintenance contracts.

In May 2022, Hensoldt, a multinational aerospace, security, and defense manufacturer and service provider based near Munich, Germany, was awarded a 5-year service contract worth roughly $500 million for Eurofighter Typhoon maintenance. The

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The next generation of Typhoons will feature increased stealth capabilities. (Illustration courtesy of Eurofighter.)

Eurofighter is planning for future generations of the Typhoon, which are expected to effectively serve for decades to come. (Illustration courtesy of Eurofighter.)

contract calls for full flight support of the planes, including increasing their flight hours, for all four of the core European operators (again, Germany, Italy, Spain, and the United Kingdom).

"We are now halfway through the contract period, and we have been able to deliver everything according to plan," says Nico Fritz of Hensoldt. "With our on-site workshops, we can ensure short response and repair times. We also provide support in the field, such as in the Baltic states or air policing at the Eastern border of the EU (European Union)."

Keeping Typhoons flying is only step one. Hensoldt is also working to keep them competitive. "The Eurofighter Typhoon is considered the backbone of many air forces in Europe and the Middle East. In order to provide longevity and to ensure that the Typhoon aircraft will continue to be a force multiplier, the fighter is receiving capability upgrades, including the introduction of a new radar system," states Fritz.

Hensoldt and its partners are developing and installing an enhanced e-scan radar called ECRS Mk1, which stands for European Common Radar System Mark 1. This advanced active electronically scanned array (AESA) radar system is designed to provide improved target detection, tracking, classification, and electronic warfare capabilities. Specifically, it will give the Typhoon a wider field of view and longer range. Initially, the upgrade is being installed on newer German and Spanish jets, with the potential for retrofitting older aircraft as well.

"The Typhoon's development isn't static," adds Filippo. "Continuous upgrades and technological advancements ensure it remains at the forefront of combat aircraft technology, capable of effectively countering evolving threats. This commitment to improvement guarantees the Typhoon's relevance and effectiveness for decades to come, solidifying its position as a cornerstone of the Italian Air Force and NATO's air power."

Italian officials have said that they expect the nation's new fleet of Typhoons be in service until at least 2060. Other nations flying this agile fighter also have similarly ambitious timelines. If these predictions hold true, we can expect to see its iconic silhouette patrolling the skies of Europe for some time to come.

AAD

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(Image courtesy of Maxwell Air Force Base Public Affairs, U.S. Air Force.)

COLONEL KEVIN R. "BUDDY" LEE
COMMANDER
AIR WAR COLLEGE
MAXWELL AIR FORCE BASE, AL

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MOVERS & SHAKERS

EXCEPTIONAL PEOPLE HELPING TO SHAPE THE FUTURE

By Paul McDonnold

SPOTLIGHT ON

COLONEL KEVIN R. "BUDDY" LEE

COMMANDER, AIR WAR COLLEGE, MAXWELL AIR FORCE BASE, AL

Educating the Future of Aviation Defense

Talking with Colonel Kevin R. Lee

At Maxwell Air Force Base in Alabama, beside a winding section of the Alabama River known as Gun Island Chute, a two-lane circular street named Chennault Circle encloses an area of roughly 48 acres. Containing such institutions as the U.S. Air Force's Air University Library, Air Force Historical Agency, and Air Command and Staff College, this circle of ground is one of the nation's critical military-intellectual centers.

In the northeast quadrant stands the Air War College. Since 1946, this postgraduate school has educated officers in all branches of the U.S. military and civilians working in many government agencies, as well as international graduates from over fifty countries. It is a good place to learn where the future of aviation warfare is headed.

AN AVIATION LIFE

Like many people who carve out careers in aviation, Colonel Kevin R. "Buddy" Lee started small — with model airplanes. Growing up, the A-4 Skyhawk and F-4 Phantom were two of his favorites. He also was drawn to books and movies on aviation, especially military, and in fifth grade attended his first air show at Randolph Air Force Base in Texas. Some of his interest may have been inherited, as his father worked as a ticket gate and air cargo agent for Delta Air Lines. But Lee wanted to be in the sky. So, he did the work in high school to start on a path to becoming a pilot. Gaining an appointment to the prestigious U.S. Air Force Academy, he graduated with a bachelor's degree in Astronautical Engineering in 2000.

Since then, Lee has served as a pilot and instructor pilot at posts from the United States to Germany to Africa, adding three master's degrees (in Military Operational Art and Science, Joint Campaign Planning and Strategy, and National Security Studies) to his resume along the way. In June 2021, he was promoted to full Colonel, and in June 2024, he assumed his current position as Commander of the Air War College.

"Being the Commander of the Air War College is one of the greatest

Colonel Kevin R. Lee assuming command of the Air War College, with the Commander and President of Air University, Lieutenant General Andrea D. Tullos. (Image courtesy of Maxwell Air Force Base Public Affairs, U.S. Air Force.)

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THE AIR WAR COLLEGE THROUGH THE YEARS

The Air War College entrance off Chennault Circle at Maxwell Air Force Base. (Image courtesy of Maxwell Air Force Base Public Affairs, U.S. Air Force.)

The Air War College began at Maxwell Field, Alabama, in 1946, as part of the U.S Army Air Forces. It was not until the next year, with the National Security Act of 1947, that the U.S. Air Force would become a separate military branch.

The Air War College's inaugural class of seventy-one students graduated in 1947. The school had an international component from the start, with two of those graduates being from Great Britain's Royal Air Force and one from the Canadian Air Force. By 1961, there were 165 graduates. The curriculum also expanded, adding an Electives Program in 1967.

The 1970s and 1980s saw the Air War College reemphasize military history as a crucial part of its curriculum, in recognition that "one cannot understand the future if one has no understanding of the past." As the twenty-first century approached, it produced key studies on the future of defense aviation.

Today, the college hosts some 245 resident students each year, both U.S. and international military officers, as well as some civilians employed by federal agencies. In the 2023–2024 academic year, it awarded 191 master's degrees. Its nonresident component is even larger, having educated tens of thousands through distance-learning programs. The sixty-five full-time faculty includes civilians and officers from the U.S. Air Force, U.S. Army, U.S. Marines Corps, U.S. Navy, and the U.S. Space Force.

Air War College students play a wargame on December 21, 2023, simulating a conflict in the Pacific. (Image courtesy of Maxwell Air Force Base Public Affairs, U.S. Air Force.)

experiences I never planned on in my life," Lee says, adding that he is "loving every minute of it."

One of the most interesting challenges has been the pivot from an operations role to leading an academic institution. "Commanding an expeditionary group in Africa or flying the line," Lee notes, "I did not have to understand the intricacies of how PhDs operate and what is required to maintain academic accreditation. That shift has required some broadening for me."

His position also has afforded him the privilege of stepping back from day-to-day operations to see the bigger picture of airpower in an operational and strategic context. This has given him insight into how missions are evolving as technology advances, directly affecting how leaders can plan and deploy manpower and resources most effectively.

"The challenge for us is how do we keep our curriculum relevant and at pace with the changes we are seeing in the environment," he says, pointing to the faculty of civilian PhDs and active-duty colonels who, rather than cloister themselves in an ivory tower, regularly interact with U.S. Air Force and joint force practitioners to keep the Air War College at the forefront of knowledge and adaptation in an ever-changing reality.

With a career that began at the dawn of the twenty-first century, such change is nothing new to Lee. "I commissioned into a peace time Air Force that was unchallenged in its ability to project power, with no competitor even on the horizon." He adds that when air power was used in Desert Storm and the Balkans, it was deployed in a conventional role that quickly "overmatched every competitor." However, he notes, "That is not where we are today."

Lee points out that U.S. airpower, though still dominant, is more contested now. The drawn-out insurgencies that followed the 9/11 attacks have led to our aircraft being deployed less in waves (as was the case in Desert Storm) and more as a full-time, persistent overhead presence for purposes such as intelligence, surveillance, and reconnaissance, as well as close air support for attacking targets near friendly forces.

Another major development Lee points to is the rise of China as a global competitor, actively working to challenge U.S. dominance in the air, compelling our defense forces to refocus their efforts. "We don't want to lose the ability and skills we learned from years of counterinsurgency, but we cannot operate the way we have for the past 20 years in the next 20 years." This raises the requirements for technical and tactical expertise across a modern contested battlespace that includes not only physical but cyber and electronic domains. In this context, maintaining digital superiority will be critical.

In the William A. Jones Auditorium, Air War College students listen to guest speaker General B. Chance Saltzman. (Photo by Melanie Rodgers Cox, courtesy of the U.S. Air Force.)

Colonel Lee addresses students at Jones Auditorium. (Image courtesy of Maxwell Air Force Base Public Affairs, U.S. Air Force.)

ARCHITECTS OF VICTORY

To produce the next generation of experts, Colonel Lee, the faculty, and the rest of the administration of the Air War College all strive to keep the curriculum on the cutting edge. They are constantly considering not only the content of courses taught, but the research being performed, the wargaming practiced, and guest speakers brought in, with the goal of exposing their students to the latest operational changes.

"Next year, for example, we are introducing a new course in our core curriculum focused on current warfighting experiences in places such as Ukraine and the changing environment in the Pacific," Lee explains. Rather than just a historical review, these courses apply lessons learned to strategic planning. Students are pushed beyond the theoretical through exercises and wargames, in scenarios that include cutting-edge cyber-attacks and unmanned systems.

For guest speakers, the college brings in subject matter experts from inside and outside the military to discuss emerging domains of warfare, such as artificial

In helping prepare senior-level officers and others for the future of military aviation, Colonel Kevin R. "Buddy" Lee calls leading the Air War College "one of the greatest experiences I never planned on."

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AIR UNIVERSITY: THE AIR FORCE’S EDUCATIONAL PILLAR

Air University is the intellectual hub of the U.S. Air Force, providing advanced education and leadership development for officers, enlisted personnel, and some civilians. Like the Air War College, the institutions below are all part of the Air University system.

AT MAXWELL AIR FORCE BASE (ALABAMA)

AIR COMMAND AND STAFF COLLEGE:

Designed for mid-career officers, this school’s curriculum emphasizes operational-level combat, leadership, and decision-making, with the goal of cultivating officers capable of integrating airpower into joint and coalition operations, while being prepared for higher command responsibilities.

IRA C. EAKER CENTER FOR LEADERSHIP DEVELOPMENT:

Providing leadership and management training programs for U.S. Air Force and U.S. Department of Defense personnel, as well as civilian undergraduates, the Eaker Center focuses on executive education, ethics, and organizational development to cultivate leaders who can impact the Air Force across all its domains.

THE SCHOOL OF ADVANCED AIR AND SPACE STUDIES:

This elite graduate-level institution’s intensive program offers both master’s degrees and doctorates in military strategy. Graduates are “warrior-scholars,” prepared for key positions from which to influence U.S. Air Force and joint operations at the highest levels.

SQUADRON OFFICER SCHOOL:

Targeting company-grade officers (such as captains), the Squadron Officer School provides foundational leadership training, critical thinking development, and operational problem-solving to ensure junior officers are prepared for future command roles.

THE THOMAS N. BARNES CENTER FOR ENLISTED EDUCATION:

Responsible for enlisted professional military education, the Barnes Center oversees the Airman Leadership School, the Noncommissioned Officer Academy, the Senior Noncommissioned Officer Academy, and the Community College of the Air Force. These schools develop enlisted leaders capable of managing and leading in increasingly complex operational environments.

AT WRIGHT-PATTERSON AIR FORCE BASE (OHIO)

THE AIR FORCE INSTITUTE OF TECHNOLOGY:

The Air Force Institute of Technology: this is the U.S. Air Force’s premier STEM-focused educational institution, providing graduate and doctoral-level programs in engineering, cybersecurity, logistics, and other technical fields critical to national defense

Colonel Lee greets General B. Chance Saltzman, Chief of Space Operations, on his January 23, 2024 visit to the Air War College. (Image courtesy of Maxwell Air Force Base Public Affairs, U.S. Air Force.)

intelligence (AI). For perspective on AI’s potential as well as its limits, the results of groups using AI are compared to those who are not. “We are pushing our students to understand where AI is, where it could be in a few years, and how to harness the benefits to warfighting, while understanding the security challenges,” Lee explains. Students and faculty also do deep dives into research projects that last from months to a year.

All of this furthers an understanding of the nature of past and current missions, while supporting the future lethality and warfighting ability of the U.S. Air Force and joint forces. This is reflected in the school’s slogan: “Forging architects of victory through intellectual rigor and creativity.”

“PEOPLE ARE MORE IMPORTANT THAN HARDWARE”

According to Lee, “The most consistent principle at Air War College, and Air University in general (see sidebar), is that people are more important than hardware. We have the responsibility and honor to educate them,” Lee says. The end goal is producing air-minded joint warfighters, who are able to lead immediately, at the O-6 and higher level, in the commands and staffs of the Air Force and the Joint Task Force. In other words, for the foreseeable future, recruiting flesh-and-blood airmen will remain as critical as ever.

Colonel Lee calls his own military service the ultimate professional achievement of his life. He recommends the U.S. Air Force to young people who are looking for an important and exciting profession. His advice to them?

“First, learn to take care of yourself and build personal resiliency. Service in the Air Force is a dedication of years of your life. You need to be physically and mentally fit to stay focused during your service. Learn to think critically, with history as a basis. Learn to read and digest ideas and communicate those ideas in written and spoken language.”

“Technology, of course, is more important than ever, but that doesn’t mean you have to be a coder (though they are welcome). We need airmen who understand how to use technology, how to find and understand facts in a sea of information.”

Lee thus predicts a U.S. Air Force of the future that embraces continuous technological advancement, yet remains human driven and focused. Technology simply will be another tool for airmen to use in protecting America’s safety and furthering its interests in inherently dangerous times. Some things never change.

AAD

Sources

AFIT: Air Force Institute of Technology, www.afit.edu; Air University, www.airuniversity.af.edu; James Mowbray, “Air War College History,” Air War College, www.airuniversity.af.edu/AWC/.

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A Gyrodyne QH-50 DASH (Drone Anti-Submarine Helicopter) in flight from the USS *Everett F. Larson* (DD-830) in 1965. The QH-50 was an early unmanned naval helicopter designed for anti-submarine warfare, carrying torpedoes to engage underwater threats, while keeping ships and crews at a safe distance. (U.S. Navy photo via Wikimedia Commons.)

NEXT-GENERATION ROTARY-WING UAVS

Blurring the Line Between Manned Helicopters and Unmanned Rotorcraft

By Andrea Templeton

On January 14, 1942, a small group of engineers and onlookers gathered at the Vought-Sikorsky plant in Stratford, Connecticut, for the first flight of the XR-4, a prototype that would become the U.S. military's first operational helicopter, the Sikorsky R-4. While only minutes long, the flight served as proof of concept for capabilities that expanded aviation missions both in and out of the military: vertical take-off and landing (VTOL) and the ability to hover.

The addition of rotorcraft to the U.S. military opened a new era of aviation that changed how it conducted search-and-rescue, reconnaissance, tactical attack, transport, and countless other missions. Previously, such missions were carried out by small, fixed-wing aircraft that needed clear runways or stretches of road to take off and land. Operating in locations without such space demanded either amphibious craft or painstaking ground support, putting multiple soldiers at risk.

As helicopters and their use evolved through the 1940s and 1950s, engineers began exploring how unmanned rotorcraft might take on similar missions. A notable example was the Gyrodyne QH-50 DASH, an unmanned naval helicopter introduced in 1963 for anti-submarine warfare. With a maximum takeoff weight of 2,250 pounds, it carried two Mark 44 or Mark 46 torpedoes and was remotely piloted from destroyers to attack distant submarines. Due to limited endurance, unreliable guidance systems, and vulnerability to foul weather, the QH-50 suffered high accident rates, leading to its retirement in 1970.

Still, the DASH program laid the groundwork for engineers pioneering the technology involved in rotary-wing unmanned aerial vehicles (UAVs, also called drones). Remote control systems, automatic landing, and payload integration were among the innovations of that era, but constraints such as primitive sensors, short-range communication links, and mechanical failures limited the effectiveness and longevity of these early unmanned aerial systems (UAS, referring to the UAV and its operating system).

THE R-4'S FIRST RESCUE

Lieutenant Carter Harman (standing left) with ground crew members during World War II. Harman piloted the first successful helicopter combat rescue in 1944, using a YR-4B to evacuate four Allied personnel from behind enemy lines in Burma. (Image courtesy of the U.S. Air Force Museum / 386th Air Expeditionary Wing.)

The Sikorsky R-4 helicopter was delivered to the Army in 1942, reaching operational readiness in 1944. In April of that year, U.S. Army Lieutenant Carter Harman flew a YR-4B (the Army's designation for the R-4) on an unprecedented rescue behind Japanese lines in Burma.

A small liaison aircraft had been forced down in hostile territory, leaving its pilot and three British soldiers stranded in jungle terrain inaccessible by a fixed-wing plane or land vehicle. Despite the R-4's modest power—particularly in the hot, humid conditions of Burma—Harman ferried each man, one at a time, to safety.

This successful operation, often cited as the first known helicopter combat rescue, showcased the life-saving potential of rotary-wing aircraft and solidified the U.S. Army's commitment to its development.

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An MQ-8B Fire Scout operates off the Coast Guard Cutter *Bertholf* near Los Angeles in December 2014. This early demonstration reflects the Coast Guard's sustained efforts to integrate unmanned aircraft for enhanced maritime surveillance and reconnaissance—part of broader advancements that continue to shape operations in 2025. (U.S. Coast Guard photo by Petty Officer 2nd Class Luke Clayton, via DVIDS.)

Nevertheless, unmanned aircraft could gather intelligence in contested areas and perform other dangerous missions, reducing air crew casualties. The realization of this potential paved the way for future investment and advances.

THE MERGE: MISSIONS AND TECHNOLOGIES BEGIN TO CROSS

By the late 20th century, advanced GPS navigation, high-resolution imaging, and satellite communication enabled UAVs to conduct prolonged battlespace surveillance. As these capabilities matured, rotary-wing drones shared missions once dominated by manned rotorcraft.

In 1999, the U.S. Navy launched the Northrop Grumman MQ-8 Fire Scout program. Designed to enhance or replace manned helicopters in intelligence, surveillance, and reconnaissance (ISR) and precision targeting support roles, this rotary-wing UAV evolved through three distinct generations. The original MQ-8A, developed from the Schweizer 330 helicopter, featured a three-blade main rotor and laid the foundation for unmanned rotary-wing ISR operations.

The second-generation MQ-8B Fire Scout introduced key capability and endurance improvements, including addition of a surface search radar. With a gross takeoff weight of 3,150 pounds and a payload capacity of 700 pounds, the MQ-8B offered over five hours of endurance and came equipped with electro-optical and infrared sensors, a surface search radar, and laser targeting systems for improved situational awareness and targeting. It served until 2022.

Building on these advancements, the MQ-8C, a Bell 407 derivative, increased endurance to over 12 hours, supported higher payloads, and had more advanced sensors and systems. First flown in October 2013, it reached initial operational capability in July 2019; its first deployment was aboard the USS Milwaukee (LCS-5) in December 2021.

AVIAN, a U.S. defense company, provides flight test and evaluation, engineering consultation, and UAS expertise to the U.S. Navy and other U.S. Department of Defense programs. Ben Teich, a former U.S. Navy helicopter test pilot, who is currently a UAS Project Officer and Program Manager at AVIAN, served as a senior flight test specialist at AVIAN during the company's support of the Fire Scout program.

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An MQ-25 Stingray refuels an E-2D Advanced Hawkeye over MidAmerica Airport, Mascoutah, Illinois, in August 2021. The second successful refueling by an unmanned MQ-25, this test flight evaluated fuel transfer, formation flying, wake turbulence, drogue tracking, and in-flight connections. (U.S. Navy photo courtesy of Boeing.)

Teich highlights AVIAN's long-term involvement with the Navy's UAS strategy and integration, "I worked for 7 years on the Fire Scout . . .This allows a depth and continuity of knowledge." He notes, "The platform filled a role — an-over-the-horizon surface search, intelligence gathering, surveillance, reconnaissance. ISR was typically filled by a manned aircraft. As the Fire Scout grew, it took over that role, sometimes operating solo, but often working in concert with manned aircraft to extend operational reach."

By pairing Fire Scout with manned aircraft, the U.S. Navy extended operational reach and reduced pilot fatigue during ISR missions. However, despite its increased capabilities, the MQ-8C was retired in 2024, making way for newer models with greater mission flexibility.

BUILDING THE FUTURE FORCE

Rotary UAVs can offer a flexible, lower-cost alternative to manned helicopters. Less training is needed than for piloted aircraft, and with more models being developed, UASs are increasingly accessible to smaller naval and ground units. Increased usage has been notable in Ukraine, where both sides have turned to drones for battlefield logistics, carrying medical supplies, ammunition, and equipment to frontline troops.

In the United States, platforms such as the Kaman KARGO and Bell Autonomous Pod Transport (APT) are being developed for autonomous resupply, while smaller off-the-shelf UAVs complement larger models for rapid supply drops. In 2024 exercises in the Philippines, the U.S. Marine Corps demonstrated the Tactical Resupply Unmanned Aircraft System (TRUAS). The U.S. Navy's Blue Water Maritime Logistics platform also has been shown to support long-range, unmanned ship-to-ship and ship-to-shore cargo deliveries.

The MQ-25 prototype aircraft has already completed refueling demonstrations with aircraft such as the F/A-18, E-2D, and F-35C.

The U.S. Navy's MQ-25 Stingray is designed to extend the reach of carrier-based fighters. The MQ-25 prototype aircraft has already completed refueling demonstrations with aircraft such as the

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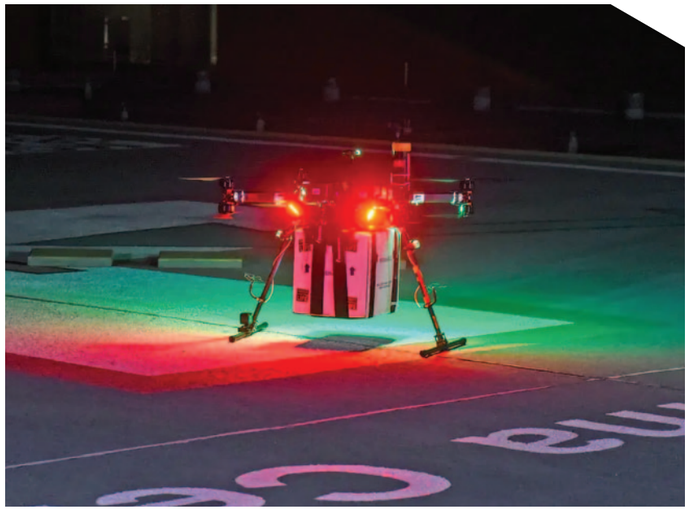
FAA REGULATIONS: PARTS 107 AND 108

The Federal Aviation Administration (FAA) regulates UAV use in the National Airspace System. Part 107 of the Federal Aviation Regulations, currently in force, limits small UAVs to visual-line-of-sight operations below 400 feet, enabling some commercial drone services but severely restricting applications such as cargo delivery and infrastructure inspection.

Part 108, expected by 2026, will ease beyond-visual-line-of-sight (BVLOS) operations and enable single pilots to simultaneously control multiple drones. This change will expand potential uses of UASs and support large-scale drone logistics, long-distance medical supply, and disaster response.

According to John Slaughter of the University of Maryland UAS Research and Operations Center, "Part 108 will truly enable large-scale commercial drone use in the United States. While past FAA regulations permitted limited commercial and public safety use, this update will grant industry and the public sector—such as package delivery and emergency response—greater flexibility. BVLOS operations will leverage high levels of autonomy, allowing drones to perform roles previously limited to piloted aircraft."

Slaughter highlights examples such as infrastructure inspection and high-resolution mapping using LiDAR and computer vision that will be unleashed by Part 108. To date, regulatory challenges have limited commercial viability of these drone missions by requiring operators to keep them in sight at all times. The new rules will make them profitable, for example, by allowing routine inspection of long linear structures such as power lines or pipelines. Slaughter predicts we also will find new and unexpected uses for the technology, once its use is less restricted.



A team led by the University of Maryland UAS Test Site (now the UAS Research and Operations Center) designed, built, and flew this drone for use in the world's first-ever drone delivery of a viable human organ. In 2019, the kidney was transported over Baltimore to the University of Maryland Medical Center and successfully implanted in a recipient who is still with us today. (Image courtesy of the University of Maryland UAS Research and Operations Center.)

Uncrewed ground and aerial vehicles assess injuries on medical manikins during the DARPA Triage Challenge ambush course at Guardian Centers in Perry, Georgia. The challenge tests autonomous systems' ability to identify and prioritize casualties in complex, high-threat environments. (Image courtesy of the DARPA Triage Challenge.)

F/A-18, E-2D, and F-35C. While still in advanced testing and pre-production at the time of this writing, the Stingray is expected to reach initial operational capability in 2026.

The U.S. Defense Advanced Research Projects Agency's (DARPA's) ANCILLARY program aims to create a runway-independent combat drone for ISR, strike, and logistics, capable of operating from ships or austere locations. The U.S. Army's Future Vertical Lift (FVL) program is integrating VTOL drones with next-generation rotorcraft, such as the Bell V-280 Valor and Sikorsky Defiant X. The first FVL airframe was delivered to its assembly facility in early 2024, and testing is scheduled to begin in 2025. And Bell's High-Speed Vertical Take-Off and Landing (HSVTOL) initiative is developing high-speed VTOL drones for autonomous strike, resupply, and refueling.

The U.S. Navy's FVL efforts also have been continuing on the path of pairing unmanned systems with manned aircraft. In addition, the U.S. Special Operations Command (USSOCOM) is exploring hybrid-electric VTOL drones for covert reconnaissance, resupply, and direct action.

EDUCATION AND INDUSTRY GROWTH

One of the institutions driving innovation is the University of Maryland's UAS Research and Operations Center (UROC). Located near Patuxent River Naval Air Station in California, Maryland, and part of the university's Aerospace Engineering Department, UROC leads efforts aimed at advancing development of UAS and integrating drones into the National Airspace System. Through STEM (science, technology, engineering, and mathematics) outreach and internships, UROC gives students hands-on experience, encouraging them to pursue careers in aerospace, defense, and commercial industries. UROC experts draw on decades of military and civilian aviation experience to advance safe, responsible UAV applications.

"We support the research and education missions at the university," says John Slaughter, who leads the center. At present, his team is focused on multi-agent systems, beyond-visual-line-of-sight (BVLOS) operations, and medical drone deliveries. UROC also assists agencies, such as the National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), Homeland Security, and the U.S. Department of Defense with UAS research and operations. "We help get their projects up in the air, so they don't have to do that themselves," Slaughter explains.

Medical drone deliveries, one of the most impactful uses, can transport critical supplies in rural areas and even speed human organs from donor to recipient. Slaughter's team leads a USDOT-funded pilot project on Maryland's Eastern Shore and hopes to scale operations: "We're looking at medical drone deliveries in areas where traditional logistics are problematic."

TO THE RESCUE

UAVs also can be used to assist in search and rescue using cameras, infrared, and other specialized sensors to locate missing persons and mass casualty victims and evaluate their injuries. The DARPA Triage Challenge represents a groundbreaking effort to use aerial and ground robots to automate triage following events like plane crashes or natural disasters. "The idea is that a truck can pull up, deploy a set of drones and ground robots, and within minutes, they're locating victims and assessing their condition," Slaughter explains.

Aerial drones conduct surveys of the disaster area, identify potential victims, and relay their locations to ground robots, such as Boston Dynamics's Spot model, which moves in for closer evaluation. "These robots use sensors to detect respiration and heart rate, and AI to communicate with victims, helping direct medics to the most critical cases first," Slaughter notes. While still in the early research phase, he believes this technology has both military and civilian applications, reshaping emergency response efforts.

Still, there are mission-critical situations best left to manned helicopters. Large-scale firefighting operations, for instance, often require heavy water or chemical payloads and the invaluable on-scene decision-making of a skilled crew. Rescue and Medevacs situations, especially for urgent trauma cases, likewise depend on human expertise and onboard medical professionals. And oversight is necessary to manage the unexpected. "From a true autonomy standpoint, if

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Members of the Threat System Management Office unbox and test drones for use during Marne Focus 2024 at Fort Stewart, Georgia, in April 2024. Exercises like Marne Focus continue to play a critical role in validating brigade readiness for future combat scenarios, including upcoming rotations at the U.S. Army's National Training Center at Fort Irwin, California. (U.S. Army photo by Staff Sergeant Jacob Slaymaker, via DVIDS.)

SMART SWARMS

Beyond ISR and logistics, unmanned systems serve as force multipliers through Cooperative Combat Aircraft (CCA), working alongside human pilots. "You're starting to see more use of unmanned aircraft—not just rotorcraft, but in general—as combat multipliers," points out Ben Teich. Rather than replacing human pilots, CCAs enable a pilot to also direct unmanned wingmen.

Autonomous drone swarms represent the next step in force multiplication. Rather than relying on human coordination like CCAs, these fleets can operate as autonomous, self-organizing units. By following localized rules, they form adaptive, intelligent networks that execute missions with minimal human oversight.

Unlike fixed-wing swarms, such as the U.S. Navy's Low-Cost UAS Swarming Technology (LOCUST) program, which is optimized for long-range, high-speed operations, rotary-wing and VTOL swarms excel in confined spaces and urban warfare, where precision maneuvers and controlled hovering are critical. Although VTOL and rotary drones expend more energy to hover, limiting endurance, their ability to land, recharge, and redeploy quickly, often where fixed-wing platforms cannot, makes them ideal for short-range, high-impact missions.

Unlike fixed-wing swarms that generally rely on pre-programmed or manually controlled formations, rotary-wing swarms have the potential of autonomously adapting fluidly to changing battlefield conditions. Equipped with AI and multiple capabilities, these UASs can dynamically reassign roles within the swarm based on mission priorities and real-time scenarios. For instance, some may be redirected to conduct surveillance or jam communications, while others strike targets.

Several VTOL swarm programs and UAS are under development or in early operational stages. Anduril's ALTIUS-600M is a modular VTOL drone designed for swarm deployment across air, ground, and sea platforms. DARPA's OFFensive Swarm-Enabled Tactics (OFFSET) program focuses on VTOL swarms for urban combat scenarios, enhancing their ability to operate in confined spaces. China and Israel also are testing rotary-wing swarm capabilities, including AI-driven formations for ISR and electronic and physical warfare.

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▲ A Wisk Aero autonomous air taxi on the runway, showcasing next-generation electric vertical takeoff and landing (eVTOL) technology. As an AI-driven, pilotless aircraft, Wisk illustrates the critical role autonomous VTOL UAVs are poised to play. (Image courtesy of Wisk Aero.)

you tell an aircraft, 'Go from home base to this field and pick up an injured person' you can't yet do that fully autonomously, because it still requires an operator to make decisions in abnormal situations," Teich noted.

AUTOMATION TO ARTIFICIAL INTELLIGENCE (AI)

When the R-4 prototype took its first flight, rotary-wing aircraft required constant pilot input. By the 1950s, stability augmentation systems (SAS) helped dampen oscillations and improve control response, and early autopilots maintained altitude and heading. Later, fly-by-wire replaced mechanical linkages with electronic controls, paving the way for integrated flight director systems and AI-driven automation.

Yet, as Teich points out, fully autonomous decision-making in unpredictable environments remains a challenge. Programs such as DARPA's Aircrew Labor In-Cockpit Automation System (ALIAS), which focuses on developing advanced automation to assist or replace human pilots in existing aircraft, are working to address this. Separately, research initiatives such as the Artificial Intelligence and Autonomy in Multi-Agent Systems (ArtIAMAS), led by the University of Maryland, are pushing the boundaries of collaborative AI and autonomy across multiple unmanned platforms and advancing intelligent, networked flight systems.

This issue is critical in urban settings, where air taxis and small UAVs will need to navigate congested, complex airspace at low altitudes, without a human pilot making in-flight adjustments or air traffic controllers ensuring safe separation. Despite ongoing regulatory and technological advancements, safely operating autonomously in such environments remains difficult. Industry and the Department of Defense are working on agile sense-and-avoid systems, such as the U.S. Navy's Guardian.

Unlike human pilots, who rely on

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An Erickson Air-Crane helicopter departs on an Autonomous Landing and Hazard Avoidance Technology (ALHAT) LIDAR test flight from NASA's Dryden Flight Research Center in July 2010. The flight-tested terrain recognition and LIDAR systems were developed by NASA Langley and Jet Propulsion Laboratory to enable safe landings. (NASA photo by Tony Landis.)

visual judgment to assess hazards like power lines or unstable terrain, UAS controllers depend on sensors and AI to evaluate landing zones. Advanced sensor suites—combining LiDAR (Light Detection and Ranging), radar, infrared, and high-resolution imaging systems—enable UAVs to map terrain and detect obstacles dynamically. Advancements in LiDAR, which uses laser pulses to create detailed 3D maps of the environment, are critical to enhancing drone autonomy by enabling unmanned systems to identify surface features and potential hazards.

Still, replicating human-level decision-making about what constitutes a safe landing site remains complex. "How does it decide what is safe to land on and what isn't?" Teich poses. "That's where the human mind still takes that role and responsibility." Since UAVs may experience communication delays or loss of control links, the ability to recognize and react to environmental conditions in real time is crucial.

Over the past decade, visual tracking and terrain assessment technologies have advanced rapidly. LiDAR generates detailed 3D maps, while AI-driven vision algorithms analyze terrain for hazards. Combined with infrared and radar-based mapping, these systems enable unmanned rotorcraft to operate in austere environments.

A COLLABORATIVE FUTURE

Looking ahead, AI-driven flight systems promise to reduce training demands and enable lighter, more resilient airframes. Integrated sense-and-avoid technology, leveraging LiDAR, computer vision, acoustic sensors, radar, and ADS-B signals, will improve UAV's situational awareness, open up more airspace, and better support crucial missions.

From the XR-4's first flight in Connecticut to today's cutting-edge rotary UAVs, the evolution of vertical-lift aviation has reshaped military and civilian operations. Unmanned systems now handle tasks from covert reconnaissance to humanitarian relief, while manned helicopters remain indispensable for complex missions requiring direct human control.

The line will become more blurred, as hybrids evolve that combine more of the endurance of fixed-wing designs, VTOL maneuverability, and advanced flexibility, capabilities, and decision-making strengths of manned helicopters. Autonomous eyes in the sky, battlefield medics, and resupply drones may become everyday tools, as human-machine collaboration continues to define the future of military aviation.

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BIGGER THAN THE SUM OF ITS PARTS

Millions of C-130 parts have passed through the 21st Logistics Readiness Squadron Aircraft Parts Store at Peterson Space Base in Colorado, en route to C-130 maintainers around the globe. (Image courtesy of the U.S. Air Force.)

By Patrick J. Walsh

However you count the number of individual parts assembled in each Lockheed C-130J Super Hercules in the U.S. Air Force fleet—for instance, whether you consider an engine as a single part or count its individual pieces—the total likely stretches into the thousands. Of course, this means that there are thousands of individual parts on each airframe that, at one point or another, probably will need to be replaced.

With that in mind, the U.S. Air Force maintains a vast inventory of replacement parts for the C-130J, as well as a large contingent of expert maintainers who diagnose mechanical issues and implement necessary repairs. The Aircraft Parts Store at Peterson Space Force Base in Colorado, for example, hosts an inventory of millions of C-130 parts that can be ordered by Air Force maintainers around the globe.

Operated by the 21st Logistics Readiness Squadron of the U.S. Air Force Reserve's 302nd Airlift Wing, the Parts Store fulfills custom requests with packages of parts tailored to any given repair scenario. A 2016 estimate placed the inventory of C-130 parts warehoused by the 21st Logistics Readiness Squadron Aircraft Parts Store at 44.5 million, and then some. The squadron's efforts and this vast inventory effectively help keep legacy Hercules flying.

Sources: "Kasia Kerridge, "Peterson, Schriever and Cheyenne Mountain Air Force installations renamed to Space Force Monday," KKTV Colorado Springs, CO, July 2021, www.kktv.com; Amber Grimm, "Peterson's aircraft parts store keeps C-130's flying," U.S. Air Force press release, August 2016, www.302aw.afrc.af.mil; Phillip Swartz, "Pentagon acquisitions office has millions in unused C-130 parts, watchdog says," *Air Force Times,* June 2015, www.airforcetimes.com.

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FIGHTERS

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(U.S. Air Force photo by Staff Sgt. Stefan Alvarez.)

Armament ACE and Mission-Ready Airmen Enabler

MARVIN TEST SOLUTIONS

Munitions continue to evolve at a rapid pace incorporating lessons learned from the Korean, Vietnam, and Gulf War-era deployments. Since the introduction of the AIM-120 air-to-air missile in the 90s, munitions manufacturers have been pushing the boundaries, developing weapons that are not only highly lethal, but unaffected by environmental and enemy threats.

As the U.S. Air Force further refines what is needed to Fly, Fight, and Win, it has adopted a new operational doctrine called Agile Combat Employment (ACE). ACE, like the overarching directive to Accelerate Change or Lose from Gen. Charles Q. Brown, Jr., requires many elements to be successful. Two critical enablers of ACE are Mission-Ready Airmen and tailored force packages.

Achieving the ACE objectives can be especially challenging for armament system maintainers. To maintain fighter aircraft armament systems, over a dozen different test sets are currently used on the flightline and in the backshop. This task is further complicated by the limited capability of some test sets that only perform a single function within armament on a single aircraft, while others perform a single function, but on multiple aircraft. To illustrate this further, an F-16 unit can deploy with as many as five test sets, each required for a different function or mission, and some missions can require the use of all five.

THE CHALLENGES OF FIGHTER ARMAMENT TEST

Armament test is further complicated with the introduction of next generation Smart weapons that cannot be fully tested with the current generation of test sets. For example, testing a fighter aircraft's digital communications systems can be challenging, but when trained and equipped with legacy test equipment the task becomes nearly impossible. Current Air Force armament test sets can only test the aircraft they were fielded with, and often lack the ability to perform the functional tests required to support the next generation of Smart weapons.

Two major challenges face any unit employing these legacy test sets. First, the immense undertaking of training and becoming proficient with armament test utilizing a laundry list of test equipment. And secondly, correctly testing digital communication systems with these outdated test systems.

A key requirement for the successful execution of the ACE CONOPS is the Mission-Ready Airman, an individual cross-trained and proficient at multiple skills necessary for mission generation. However, it is important to understand the difference between successfully completing a training course and being deemed proficient. Training usually requires the completion of a prescribed course or a set of tasks. Becoming proficient can take a person's whole career in some cases, but typically requires a task to be repeated and accomplished numerous times after training is complete.

Testing armament systems with the current challenges can negatively impact operational performance and degrade the mission at hand. If test sets with extreme limitations are utilized to determine the armament system's reliability, aircraft can be deployed partially tested, thus jeopardizing overall mission success and potentially warfighter safety. The unfortunate truth is many munitions or armament system failures will not be identified and resolved with currently deployed test sets.

ACE ENABLER – ARMAMENT TEST

Fortunately, an ACE and Mission-Ready-Airmen enabling solution is available now for armament test. The MTS-3060A SmartCan™ enables the successful execution of the ACE CONOPS by combining the required technology needed to properly test legacy analog circuitry and next generation digital systems. This is all accomplished in a ruggedized, handheld test set that is easy to deploy, use, and maintain. The SmartCan weighs less than 4 lbs., yet delivers fast, comprehensive test capability at the flightline to ensure full mission capability for the warfighter. The SmartCan has replaced legacy passive testing with advanced active testing and munition simulation; with active simulation the maintainer becomes the pilot. If test procedures mimic munition expenditure procedures,

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the maintainer on the ground can duplicate the results the pilot experiences in flight. Latency and intermittent issues can be diagnosed by employing multiple SmartCan test sets on aircraft, resembling munitions loads and fully testing the aircraft's digital subsystem.

This innovative handheld instrument incorporates capabilities to test multiple interfaces and signal types such as MIL-STD-1760, MIL-STD-1553, RS-422, RS-232, CAN-Bus, MMSI, Ethernet, RS-485, Audio, RS-170 Video, and electronic loads. Combined with the ability to test all legacy measurement channels, the SmartCan is capable of testing any armament system. Thousands of test program sets (TPSs) and test reports can be stored, enabling trend analysis and providing the basis for predictive maintenance.

MTS-3060A SmartCan Universal Armament Test Set
(shown with adapter and cable kit)

Extensive cybersecurity features, both hardware and software, make the SmartCan the most cybersecure armament test set available. The removable SD card is the only memory available; when removed, the SmartCan is effectively sanitized and contains no TPS code or saved test data. External system access from other interfaces, such as USB drives, is not available. The ATEasy™ Test Executive and Development Environment, utilized for TPS development, is designed to comply with DOD Security Technical Implementation Guide (STIG) requirements. Access control, user privileges, DLL encryption, data encryption, as well as other safeguards, ensure a secure, reliable operating platform.

The SmartCan replaces multiple legacy test sets at the flightline.

ALL PLATFORMS, ALL ARMAMENT – THE ACE-ENABLED WARFIGHTER

A single, handheld, common menu-driven test set now enables Mission-Ready Airmen to support all armed aircraft platforms with ease, thus ensuring that current and future armament test needs are met across the USAF's inventory of armed aircraft. Commonality, capability and configurability should serve as the cornerstone for armament test equipment and the MTS-3060A SmartCan achieves all of these objectives. Globally deployed and combat proven, the SmartCan (SERD #75A77) is the most advanced handheld flightline armament test set available, currently deployed on 14 platforms in 21 countries.

The SmartCan, together with all cables, adapters and test set functionality are combined in a small, rugged transit case, greatly easing the support equipment logistics burden of combat mission support for agile, tailored force packages with a minimal footprint.

Our warfighters provide the first line of defense against a wide range of threats, and it is our mission to ensure they have the finest solutions available when placed in harm's way. The Nation's responsibility not only includes the weapons platforms, but also the test systems used to keep them fully operational. The MTS-3060A SmartCan is the premier O-Level armament test set available today, enabling ACE and Mission-Ready Airmen.

We at MTS Make Test (and ACE) Easy!

ABOUT THE AUTHOR

Senior Master Sergeant Adam Wells, USAF, (Ret) is the Warfighter Support Solutions Manager for Marvin Test Solutions (MTS). He joined MTS in 2018 after retiring from the United States Air Force with 20 years of active duty service as an Armament Systems Specialist.

Adam's expertise extends to a number of aircraft platforms including the F-16, F-15C/D/E, F-22 and HH-60. He has extensive knowledge in conventional/nuclear munitions and operation, electrical testing and troubleshooting, intermediate and operational level of repair, training program creation and management, and strategic planning.

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MESH NETWORKING IS A POTENTIAL GAME CHANGER FOR SIXTH GEN AIRCRAFT

By Patrick J. Walsh

Visions of a future battlespace that is increasingly reliant on real-time, data-driven decision making must still address a problem as old as defense aviation itself: How to secure and protect communications between command and control and forward deployed forces. And with ever-increasing reliance on networked systems, often deployed in unsecured environments with degraded or denied communication capabilities or limited bandwidth, the need for a new approach to linking critical systems is a top priority.

For military planners evaluating new technologies for use in potential sixth-generation aircraft, mesh networking holds the promise of a potential solution. At its simplest, the mesh approach to local area networking links the various pieces in a network to each other, rather than information being fed from a central location. Routing data from device to device, with multiple points of data access, reduces dependence on in-line communications from the top.

In conjunction with the emerging "Internet of Things"—essentially a catchall phrase for "smart" items fitted with sensors and otherwise equipped to communicate with similarly equipped systems and devices—the integration of mesh computing in defense aircraft could provide air crews with reliable access to crucial information. For all those who are tasked with ensuring mission success and air crew and aircraft survivability, this could be a game-changer.

Sources: "The battle is won at the edge—not the data center." Anduril Industries, www.anduril.com; Antonio Cilfone, Luca Davoli, Laura Belli, and Gianluigi Ferrari, "Wireless Mesh Networking: An IoT-Oriented Perspective Survey on Relevant Technologies," *Future Internet*, April 2019, www.mdpi.com; Travis Patterson, "Bridging the Gap: How an Airborne Mobile-Mesh Network Can Overcome Space Vulnerabilities in Tomorrow's Fight," Maxwell Air Force Base, Alabama: Air University Press Wright Flyer Paper No. 71, November 2019, www.maxwell.af.mil. (Image courtesy of the U.S. Air Force.)

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A veteran of Great Britain's nascent Royal Air Force during World War I, Reginald Denny (pictured here in the 1924 book *Stars of the Photoplay*) worked as a stage and film actor during the 1920s. He parlayed his interest in model airplanes into a manufacturing plant that built thousands of radio-controlled target drones for the U.S. military during World War II. (Image courtesy of *Stars of the Photoplay*, Photoplay Publishing, 1924.)

UAV HISTORY: THE HOLLYWOOD CONNECTION

By Patrick J. Walsh

The rapidly expanding role of unmanned aerial vehicles (UAVs) in defense aviation has roots in unexpected places. In the United States, the first widespread military use of UAVs began in 1940, when the United States Army Air Corps placed an order with the Radioplane Company of Van Nuys, California, for fifty-three radio-controlled model planes for use as subscale target drones.

The featured player in the corporate hierarchy of the Radioplane Company was Reginald Denny. A well-regarded British actor, he had developed a loyal following among American movie fans during the silent screen era. A veteran of Great Britain's fledgling Royal Air Force during World War I, Denny simultaneously pursued his interests in acting and aviation throughout the 1930s. He initially operated a hobby shop for model airplane enthusiasts, which led to his developing a radio-controlled model designed for use as a military target, so recruits could be trained in the effective use of anti-aircraft artillery.

During World War II, Denny's Radioplane Company in California became the leading manufacturer of target drones in the United States. With a total wartime production run of more than 9,400 units, the company's Radioplane OQ-3 model was the U.S. armed forces' most widely used target drone. In 1952, Radioplane was acquired by the Northrop Corporation.

In the post-war era, Radioplane's manufacturing plant at the Van Nuys Airport attracted additional public fascination as the launch site for the career of one of Hollywood's most enduring film stars. During her wartime employment at the plant, an aspiring young actress named Norma Jeane Dougherty was photographed by David Conover, who was at the time assigned to the First Motion Picture Unit of the United States Army Air Forces.

Conover was sent to the Radioplane facility to document the work of female war workers by his commanding officer (and future president of the United States), Ronald Reagan, and his photo of Dougherty appeared in the U.S. defense publication *Yank, the Army Weekly*. That portrait led to her better-known career as a model and, ultimately, after she adopted the stage name Marilyn Monroe, her status as a legendary film star.

A teenaged Marilyn Monroe, then known by her married name, Norma Jeane Dougherty, worked at the Radioplane Company plant in Van Nuys, California, during World War II. This early photograph of the future Hollywood icon, from the June 26, 1945, issue of *Yank, the Army Weekly*, was taken by journalist and author David Conover. (Image courtesy of the U.S. Army.)

Sources: Russell Naughton, "Reginald Denny (1891–1967) — Aviation Pioneer," Centre for Telecommunications and Information Engineering, Monash University, Melbourne, Australia, www.monash.edu; Dana T. Parker, *Building Victory: Aircraft Manufacturing in the Los Angeles Area in World War II*, Cypress, CA: Dana T. Parker, 2013; "Radioplane OQ-2A," National Museum of the United States Air Force fact sheet, www.nationalmuseum.af.mil;
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