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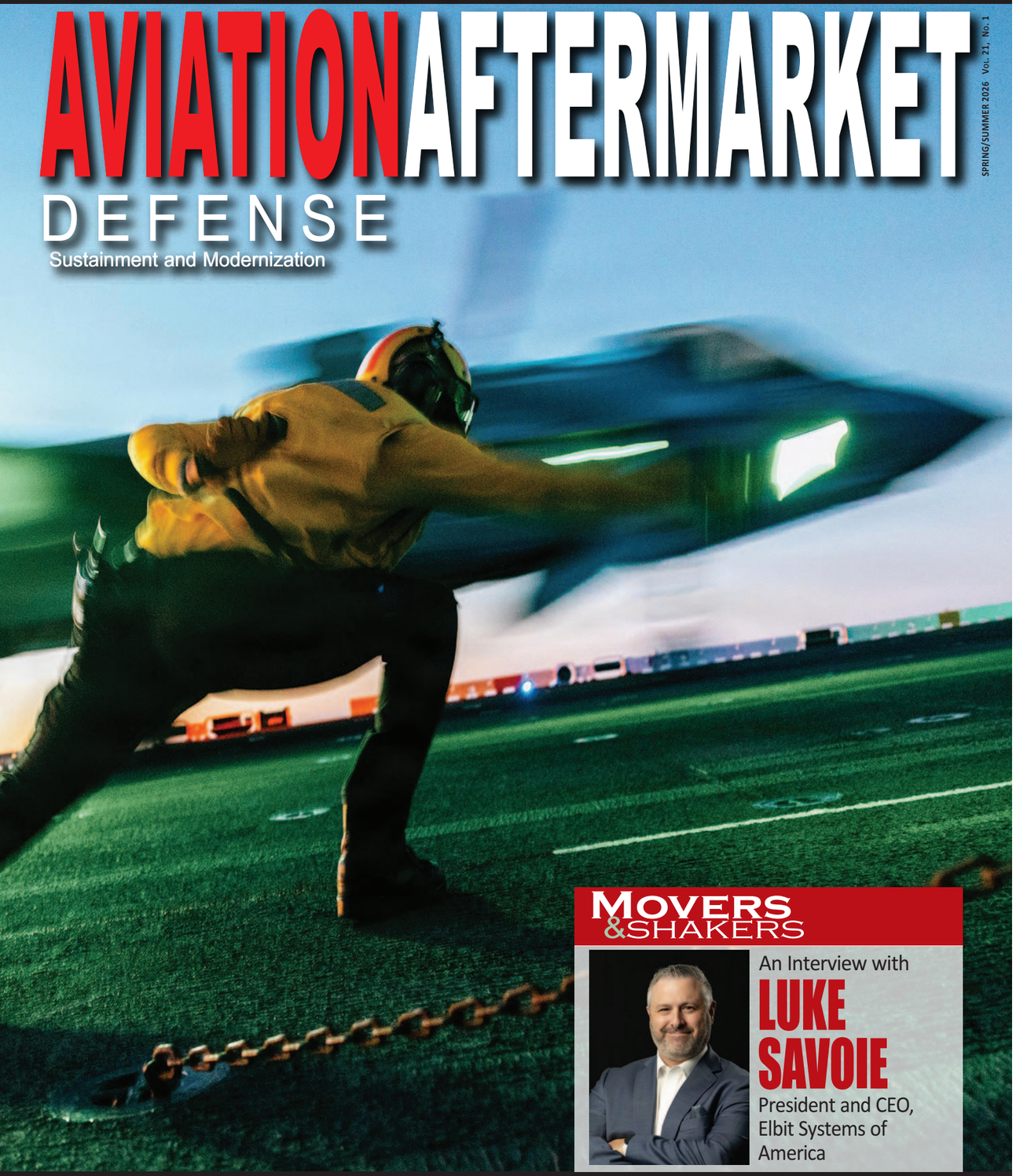
Sustainment and Modernization

SPRING/SUMMER 2026 Vol. 21, No. 1



MOVERS & SHAKERS

An Interview with

LUKE SAVOIE

President and CEO, Elbit Systems of America

INSIDE:

- THE "BIG THREE"
- ADDING AUTONOMY - HELICOPTERS
- FASTER, CHEAPER, BETTER - NORTHROP GRUMMAN'S B-21 RAIDER

AVIATION AFTERMARKET DEFENSE

SPRING/SUMMER 2026 Vol. 21, No. 1

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Staying in the Sky

As of early April, the fragile ceasefire in the war with Iran marks a critical pause for a defense aviation infrastructure that has been pushed to its breaking point. For the coalition forces led by the United States and Israel, the six weeks of "Operation Epic Fury" have shifted from a display of high-tech dominance to a grueling lesson in the logistics of attrition.

The maintenance burden has become the silent front of this conflict. While stealth assets such as the Northrop Grumman B-2 Spirit bomber delivered the initial "Roaring Lion" strikes, they also incurred a staggering 119 maintenance hours for every hour flown. This ratio, combined with a munitions transition to less expensive, short-range weapons, highlights the necessary pivot from strategic shock to more sustainable bombing campaigns. At the same time, the cost of keeping airworthy aging platforms like the airborne warning and control Boeing E-3 Sentry—many of which were already nearing retirement—continues to exacerbate the logistical nightmare.

On the other side, the Iranian Air Force remains a tenuously successful "flying museum," with legacy aircraft kept in service by a clandestine supply chain and a domestic industry that reverse engineers 1970s American technology. While the recent arrival of Russian Sukhoi Su-35s promised modernization, the current reality for Tehran is a brittle defense network. Meanwhile, domestic radars are being jury-rigged to support Russian-made S-300 missile launchers, after the original systems were decimated by Israeli strikes.

The rescue of a downed F-15E weapons officer on Easter Sunday—a mission that required the destruction of several U.S. C-130 Hercules to prevent sensitive technology from falling into enemy hands—underscores the high stakes of aviation operations and related security in hostile territory.

As negotiators gathered in Islamabad, the primary question for defense planners has not been as much about diplomatic terms as whether their fleets can be repaired faster than they are being degraded. Without a permanent peace accord in place, which currently seems unlikely, the next phase of this war, if there is one, may be won not by the best pilots flying the most agile aircraft, but by the most resilient maintainers.

This all underscores the ever more vital significance of strategic solutions and sustainable actions on the part of both the defense forces and their multiple market partners. Ultimately, the outcome of this and future conflicts may all come down to who can stay in the sky.

Richard Greenwald

Richard Greenwald
Publisher

What we obtain too cheap, we esteem too lightly: it is dearness only that gives every thing its value - Thomas Paine, The American Crisis, Dec 19, 1776

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By Terry Lloyd


(Official U.S. Navy photo.)

Pentagon Awards Contract for Newest F-35s

The U.S. F-35 Joint Program Office and Lockheed Martin have finalized a landmark agreement totaling $24.3 billion for the F-35 program. The largest production contract in the aircraft's history, the deal provides for production and delivery of up to 296 F-35 fighters. Building on a previous $11.8 billion award, 148 aircraft from Lot 18 have been definitized, with funding and scope added for an additional 148 jets under Lot 19. In addition to production, the Joint Program Office and Lockheed Martin also reached agreement on an Air Vehicle Sustainment Contract for annual sustainment activities of global F-35s beginning this year.

These announcements came amid ongoing international demand for the fifth-generation fighter. Italy and Denmark expanded their fleets by adding twenty-five and sixteen aircraft, respectively, signaling continued confidence in the platform. Other partner nations also reached key milestones, with Finland rolling out its first F-35, Belgium receiving its first aircraft on home soil, and Norway completing deliveries of its full F-35 fleet.

Pratt & Whitney Powering Lightnings

In December, Pratt & Whitney, part of RTX, secured an undefinitized contract action valued at $1.6 billion for sustainment services related to its F135 engine, which powers all three models of the F-35 Lightning II. This was followed by a contract modification worth $3.8 billion, for the production of lots 18 and 19 of the engine. The latest award brings estimated total contracts for the company related to this powerplant to more than $6 billion.

Pratt & Whitney will be ensuring continuous manufacturing of full-rate production engines, spare parts and supply chain operations, engineering resources, and dedicated program and support services. The agreement also addresses capacity requirements, tooling, and more for both the U.S. defense services and those of allied nations using F135 production engines.

According to Pratt & Whitney President, Military Engines, Jill M. Albertelli, "Pratt & Whitney is investing heavily across our global production base and supply chain to increase production and accelerate engine delivery and sustainment to meet growing global demand for the F-35 program."

Boeing Awarded U.S. Army Contract for Apache Support

Boeing announced in December that it will provide post-production support for the AH-64 Apache attack helicopter, which is manufactured at its Mesa, Arizona, facility. The $2.7 billion contract was awarded to Boeing as the sole bidder, with work to run through mid-2030.

The support services encompass tasks involved in maintaining mission readiness of the U.S. Army's Apache fleet, a vital component of the service's combat aviation capabilities. This agreement follows a more than $4.6 billion contract Boeing secured in November for ongoing Apache production, which includes sales to such foreign customers as the Polish military.

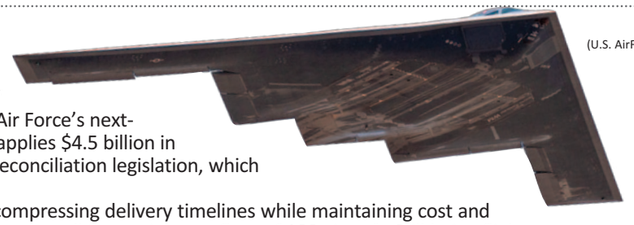
Boeing has been building Apache helicopters since 1975. Arizona officials recently marked the program's 50th anniversary, highlighting its significant contribution to the regional and state economy. Christina Upah, Vice President of Attack Helicopter Programs and Senior Mesa Site Executive, notes that nearly 3,000 Apache helicopters have been produced in Mesa, with more than 1,300 currently in service worldwide.

Lockheed Martin Gets Super Hercules Orders

The U.S. Department of War signed a framework agreement with Lockheed Martin that includes orders for domestic and overseas use of its C-130J Super Hercules. The program incorporates production of new aircraft, development, and engineering activities, as well as integration of new onboard systems. Capped at $10 billion, the contract is an add-on to a 2020 agreement valued at up to $15 billion.

Reportedly, Lockheed Martin has delivered approaching 600 C-130Js to date. Incorporating a significant extension of the wing's service life, the latest version of this capable tactical airlifter serves in multiple configurations, supporting intelligence, command, electronic warfare, special forces, search, rescue, and other transport and specialized missions. The current program is expected to include multiple international orders placed as foreign military sales, with initial national customers to include Australia, Egypt, France, Germany, New Zealand, Norway, and the Philippines.

U.S. Air Force to Accelerate B-21 Raider Production


(U.S. AirForce photo)

The U.S. Air Force and Northrop Grumman have reached an agreement to speed up production of the B-21 Raider, accelerating delivery of the U.S. Air Force's next-generation stealth bomber fleet. The agreement applies $4.5 billion in funding already authorized under the fiscal year reconciliation legislation, which will be supplemented by corporate investment.

Amid this push to accelerate manufacturing, compressing delivery timelines while maintaining cost and performance goals, the program of record continues to call for a minimum fleet of 100 aircraft. Still being flight tested, the first production model of this long-range, penetrating strike aircraft is expected in 2027.

General Dale R. White, Director of Critical Major Weapons Systems, comments, "By increasing production capacity now, we are responsibly accelerating delivery of a critical, combat-effective capability to the warfighter."

Designed to deliver both conventional and nuclear weapons, the B-21 is a penetrating stealth bomber intended to replace the B-1B Lancer and B-2 Spirit by 2040. It also will complement and potentially assume missions performed by the B-52 Stratofortress, ensuring resilient operations in contested environments.

U.S. Air Force Wedgetail Prototypes Proceed

The U.S. Air Force will move forward with its two rapid prototypes of the Boeing E-7A Wedgetail Airborne Eary Warning and Control (AWE&C) aircraft, while continuing to advocate for next steps. After lawmakers reversed earlier proposed cuts to the program in the fiscal 2026 spending and authorization bills, Congress directed the U.S. Air Force to continue work on the two prototypes, adding $1.1 billion to fund prototyping efforts and further development.

In February, U.S. Air Force Secretary Troy Meink said, "We will, of course, follow congressional direction, and we will do the rapid prototypes." An Air Force spokesperson's later statement focused on the promise of the prototypes serving as a bridge to full engineering and manufacturing development of the aircraft.

Boeing will assemble two aircraft at the existing conversion facility operated by STS Aviation in Birmingham, England. The 737-700 airframes are being built in Renton, Washington, before being transported to the United Kingdom for missionization. That work includes installing Northrop Grumman's specialized Multi-Role Electronically Scanned Array radar system. The E-7A is intended to replace the legacy Boeing E-3 Sentry fleet, which remains heavily tasked, despite its advanced age.

Funding Boost to U.S. Navy's New Fighter

The U.S. Navy's F/A-XX program has received a significant funding boost, with the U.S. Congress allocating nearly $900 million for the fiscal year 2026 defense appropriations. Defense contractors Northrop Grumman and Boeing are competing to develop the stealthy, long-range, survivable fighter jet that will eventually replace the Navy's aging F/A-18 E/F Super Hornets and E/A-18 Growlers.

As Ken Calvert (R-CA), Chairman of the House Appropriations Subcommittee on Defense, notes, "We need sixth generation fighters. The U.S. Navy needs sixth generation fighters. I am concerned that any hesitancy on our part to proceed with the planned procurement of sixth generation fighters for the Navy will leave us dangerously outmatched in a China fight. We cannot wait." U.S. Navy leaders also have emphasized the aircraft's importance in maintaining air superiority and submitted to Congress a $1.4 billion request for F/A-XX in the service's fiscal year 2026 Unfunded Priority List.

As of this writing, U.S. officials reported that the F/A-XX was in the late stages of development, with source selection still to be decided between Northrop Grumman and Boeing. Similar to the U.S. Air Force's F-47 program (awarded to Boeing), the carrier-based F/A-XX is expected to feature the increased range and advanced stealth capabilities needed for missions in the Indo-Pacific region and other extended operations. In addition to operating alongside the F-35C, the new sixth-generation fighter will serve with unmanned aircraft.

Enhancing Embraer's Millennium

Embraer and Northrop Grumman are partnering to advance the KC-390 Millennium multi-mission aircraft, adding cutting-edge air-refueling capabilities for the U.S. Air Force and allied nations. Leveraging extensive expertise in aircraft design, production integration, and advanced manufacturing, the two companies aim to shape the KC-390 multi-mission tanker to meet future aerial logistics requirements.

Embraer's KC-390 Millennium is already engineered for demanding missions and operations in modern threat environments. Planned upgrades include an autonomous aerial refueling boom, improved communications, enhanced situational awareness, survivability options, and adaptable mission systems. These enhancements will both expand the aircraft's refueling reach and broaden its versatility.

As Tom Jones, Corporate Vice President and President of Northrop Grumman Aeronautics Systems, explains, "Together with Embraer, we are investing strategically to close gaps in advanced air mobility worldwide. By listening to our customers, including allied nations seeking greater operational autonomy, we are exploring technologies that enhance the versatility of the KC-390 and deliver the independence our partners need."

Bosco da Costa Junior, Vice President and CEO of Embraer Defense & Security, adds, "This collaboration combines the strengths of two defense leaders, focusing on a boom refueling system for the KC-390 Millennium. The platform is operationally proven, cost-effective, and can be rapidly integrated into the U.S. Air Force and allied inventories."


Photo: BAE Systems

BAE Systems Providing More Missile Warning Systems

BAE Systems has secured a $137 million foreign military sales contracts from the U.S. Army to deliver additional AN/AAR-57 Common Missile Warning Systems (CMWS) to allied countries. This latest order will provide CMWS units for international operators looking to safeguard current and newly introduced aircraft fleets, including AH-64 Apaches, CH-47 Chinooks, and UH-60 Black Hawks.

Originally introduced to counter the rising threat of infrared-guided missiles, particularly shoulder-fired weapons, the AN/AAR-57 has evolved with the threat environment. Modern risks include increasingly sophisticated seeker technology, radio-frequency guidance systems, and the spread of man-portable air defense systems in volatile regions. CMWS detects missile launches and hostile fire by identifying infrared and radio-frequency signatures. When a threat is recognized, it alerts the aircrew and automatically deploys appropriate countermeasures, significantly improving survivability.

Designed for multi-platform compatibility, CMWS requires minimal modification for installation. Its line-replaceable units can be changed directly on the flight line within minutes and without specialized tools—an important advantage for forces operating in austere or forward-deployed environments.

To date, more than 3,000 CMWS units have been delivered globally, integrated across over forty rotary and fixed-wing aircraft types. The system has logged more than 4 million combat flight hours on U.S. and allied platforms. With this contract, CMWS-equipped aircraft will be in service with more than twenty nations.

Saudi Arabia Orders Four Maritime Patrol Aircraft

Aircraft manufacturer Leonardo has received an order for four C-27J Maritime Patrol Aircraft (MPA) from the Kingdom of Saudi Arabia's Ministry of Defense. The new aircraft will enhance the country's capabilities to address modern submarine and surface threats, provide efficient search and rescue operations, and conduct transport and airdrop missions.

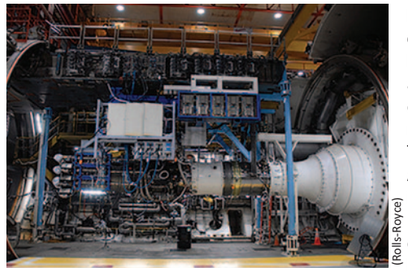
This order strengthens the longstanding partnership between Leonardo and Saudi Arabia, increasing the number of C-27Js operated in the Kingdom. It follows a recent acquisition of two C-27Js for firefighting, medical evacuation missions, and other cargo transport. This procurement of the C-27J MPA with integrated maritime weapon systems highlights its flexibility in combining transport, disaster response, and surveillance roles.

The C-27J MPA maintains the advanced features of the C-27J Spartan Next Generation platform, including advanced avionics, navigation, communication, identification, and self-protection systems. These ensure safe, low-workload operations in all weather and lighting conditions, both in civil and military airspace, including high-threat environments.

For maritime surveillance, the aircraft is equipped with a dedicated mission suite featuring sensors optimized for detecting, identifying, and tracking surface and submarine targets. These are managed through Leonardo's Airborne Tactical Observation and Surveillance (ATOS) system, which provides advanced mission management and data fusion capabilities.

A robust communication suite enables real-time data sharing with command centers and coordinated operations with other units, including beyond line of sight scenarios. Additionally, the C-27J MPA can carry a significant weapons payload to counter threats such as torpedoes, anti-ship missiles, and depth charges.

(Leonardo)



(Rolls-Royce)

Rolls-Royce Completes Key Tests for Engine on Upgraded Bombers

Rolls-Royce has successfully finished altitude and operability testing for its F130 engine, set to power the U.S. Air Force's modernized fleet of Boeing B-52J bombers. The trials took place at the Air Force's Arnold Engineering Development Complex in Tullahoma, Tennessee.

The testing program evaluated the engine's performance during long-duration, high-altitude flights, including conditions simulating real-world turbulence. Engineers also assessed the new Integrated Drive Generator, which will supply electrical power during missions. "Throughout this F130 engine test campaign, we gathered essential data about how this engine operates across the full spectrum of flight conditions," explains U.S. Air Force Lieutenant Colonel Timothy Cleaver, who oversees the B-52 engine replacement project.

The F130 completed its critical design review in late 2024, paving the way for the first flight test engines. Eight F130 engines, adapted from Rolls-Royce's BR725 commercial engine, are planned to replace Pratt & Whitney TF33 engines as part of the B-52 Commercial Engine Replacement Program.

The B-52J upgrades go beyond propulsion. Each of the U.S. Air Force's seventy-six bombers also will receive Raytheon's AN/APQ-188 active electronically scanned array radar, upgraded communications systems for both conventional and nuclear missions, advanced avionics, and revamped crew compartments. Initial operational capability for the B-52J, including the new radar and engines, is anticipated by 2033.

Canadian and Australian C-17 Airlifters Get Better Countermeasures

The U.S. Department of Defense has awarded Boeing a $13.1 million dollar contract to upgrade infrared countermeasures on C-17 Globemaster III transports operated by Canada and Australia. Designed to shield the aircraft from heat-seeking missiles by diverting threats toward decoys, these countermeasures can take the form of flares, lasers, or electronic interference that disrupt enemy targeting systems.

Under the agreement, Boeing will provide upgraded systems for five C-17s flown by the Royal Canadian Air Force and eight in the Royal Australian Air Force fleet. The program will transition existing Block 10 countermeasures to the latest Block 30 configuration and includes installation and technical support. The Globemasters' mission computers also will be replaced to enhance digital capabilities and enable integration with future systems.

Work will be carried out at Boeing's San Antonio, Texas, facility and is expected to be completed by mid-2030. Project coordination will involve the U.S. Air Force Life Cycle Management Center in Warner Robins, Georgia.

This contract comes shortly after Boeing received a separate agreement to modernize the U.S. Air Force's C-17 flight decks. These and other upgrades will be aimed at extending the effective operational life of the C-17 fleet through 2075.

Canada Chooses Homemade Bombardier Aircraft

The government of Canada has placed an order for six Bombardier Global 6500 aircraft to serve the Royal Canadian Air Force, replacing the force's aging CC-144 Challenger fleet. The Global 6500 business model will be modified for missions such as medical evacuations, disaster relief, humanitarian aid, and national security operations. The order is estimated at more than $540 million U.S., with much of that cost for the modifications. The contract also includes aircrew, maintenance, and military-specific training and services. The aircraft will be assembled in the Toronto area and completed near Montreal, with first deliveries and initial operational capability anticipated in 2027.

Per Éric Martel, President and Chief Executive Officer, Bombardier, "The Global 6500 aircraft is a world-class, made-in-Canada product with the versatility to perform multiple missions, making it the go-to solution for governments around the world. Today, the more than 12,000 Canadians who work at Bombardier can take great pride in knowing that this aircraft will now serve their country."

Stephen Fuhr, Canadian Secretary of State for Defence Procurement also notes, "Canada has a world-class aerospace industry, and this investment will harness that strength to create good-paying jobs, drive innovation, and bolster our security."

South Korea to Deliver First Boramae Fighters

South Korea is set to deliver the first production models of the KF-21 Boramae to the Republic of Korea Air Force (ROKAF) in 2026, signaling a major milestone as the country shifts its premier fighter program from development into active service. Local reports indicate the initial serial-production aircraft will be transferred after completing final acceptance trials. This will be the first operational deployment of a domestically developed fighter led by Korea Aerospace Industries (KAI).

Previously known as the KF-X program, the project has been one of South Korea's most significant defense undertakings. The Boramae will replace the Air Force's aging F-4 Phantom II and F-5 Tiger II fleets, while decreasing its reliance on foreign-built combat aircraft.

The KF-21 features a reduced radar cross-section, integrated sensor fusion, and network-enabled combat systems, placing it in the "4.5-generation" category of multirole fighters tailored to South Korea's strategic requirements. The first batch to reach initial operability will consist of Block I variants, configured primarily for air-to-air operations. More advanced Block II versions are expected to enter service later in the decade.

Kratos and Northrop Grumman Collaborate on CCA

Kratos Defense and Security Solutions and Northrop Grumman have partnered to collaborate on the U.S. Marine Corps's Marine Air-Ground Task Force Uncrewed Expeditionary Tactical Aircraft (MUX TACAIR) Collaborative Combat Aircraft (CCA) program, after successfully competing for an Other Transaction Agreement initially valued at $231.5 million for a period spanning 24 months. Their teams will be working together to further develop the XQ-58 Valkyrie autonomous drone to provide additional strike and intelligence-gathering capabilities, serving alongside the Marine Corps's manned fighters, including the F-35 and the forthcoming F-47.

Northrop Grumman's advanced mission kits, including sensors, the Prism open-architecture autonomy software, and other software-related technologies, will be integrated with Kratos's Valkyrie unmanned system, which has already undergone extensive testing with the Marine Corps and the U.S. Air Force. The updated model's advanced systems and modular design will ensure it is capable of multiple mission configurations. Kratos's recently opened manufacturing facility in Alabama will be involved in production of this loyal wingman model.

Peru Seeking Fighters and Missiles

The U.S. State Department approved the unfinalized sale of twelve Lockheed Martin F-16C/D Block 70 jets to Peru and various missiles, in a package valued at $3.42 billion. Reportedly, Peru's leadership has advanced potential plans to acquire this number, plus twelve more of the aircraft, in a deal to include advanced radar systems, electronic warfare gear, and additional armaments. Presumably, any such purchase will include pilot and ground crew training, spare parts, and sustainment services.

The nation's goal is to replace aging combat aircraft, including fighters that have been in service since the Cold War era. Peru currently flies eight Mikoyan MiG-29s, eight Sukhoi Su-25s, eleven Dassault Mirage 2000s, and twenty Cessna A-37s. Its air force needs to support sovereignty patrols, counter-narcotic interjections, other reconnaissance and strike missions, and disaster response across a vastly varying terrain. The F-16 would both increase capabilities of meeting these requirements and provide key interoperability with allied nations.

(Images courtesy U.S. Air Force.)

THE "BIG THREE"

Operating in Electronically Contested and Denied Environments
By Donna Kelly

The Boeing C-17 Globemaster III, Boeing KC-135R/T Stratotanker, and mighty Lockheed C-130 Hercules are all well-known, robust, and long-serving aircraft. These venerable transport models capably serve as members of a crucial team of airborne haulers that work together or separately to fulfill the needs of today's diverse theaters of operation. These days, they need to do so even when operating in electronically contested and denied environments.

BUT FIRST, LET'S PUT THINGS INTO PERSPECTIVE

Today's U.S. Air Force operates a wide variety of cargo-carrying aircraft that range from really big to small. While not focused on in this article, we must start with the Lockheed C-5 Galaxy, the largest military aircraft in the world, capable of carrying 281,000 pounds of cargo. Built from 1968 to 1973, the Galaxy is on its way out of inventory, though fifty-two are still flying, having been upgraded to the C-5 Super Galaxy standard with more powerful engines. As with other legacy defense aircraft, the C-5's service life has been extended, and it is now expected to fly until 2040.

Second in size to the Super Galaxy is the Lockheed Martin C-17 Globemaster III, the big bird of choice for long hauls. Besides its massive 179,900 pounds of cargo capacity, it can deliver goods and troops via airdrop, or by landing on primitive and short runways around the world. When on the ground, a C-17 can supply fuel to other aircraft, including helicopters, fighters, and even the Northrop B-2 Stealth Bomber, arguably the most vital asset in today's arsenal for deterring nuclear proliferation in rogue nations.

Produced from 1991 to 2015, the C-17 has undergone multiple upgrades. Originally scheduled to have a service life of 30,000 hours, some reached 20,000 of those hours as early as 2013, and this capable carrier is still going strong. Now that it is expected to fly until 2070, it can be said that the last C-17 pilots have not even been born yet.

The smallest of the Big Three discussed here is the Lockheed Martin C-130, including its many variants. The latest H and J models can transport up to 47,000 pounds of cargo and airdrop it, or, like the C-17, land on short, unimproved landing strips. Yet the mighty Herc can get into places that its bigger sister the Globemaster cannot. Both aircraft are designed for landing in austere environments, but the C-17 requires runways at least 90 feet wide, while the C-130's significantly smaller size enables it to operate on runways as narrow as 60 feet. It also is more maneuverable on the ground, making it the primary choice for forward-operating bases and disaster-stricken areas.

This image illustrates the size difference between a C-5 Super Galaxy and a C-17 Globemaster. (U.S. Air Force photo by Senior Airman Robert Nichols.)

A C-17 Globemaster III conducts flare testing operations at Eglin Air Force Base, Florida, earlier this year. Eglin units coordinated flare-testing operations to evaluate and field improved defensive-system capabilities for U.S. Air Mobility Command aircraft. (U.S. Air Force photo by Master Sergeant J.D. Strong II.)

The last of the Big Three is the Boeing KC-135R/T Stratotanker. With the exception of being unable to air drop cargo, this incredible airplane does what the other cargo planes can do and more. While technically considered an aerial refueler, the multi-purpose Stratotanker can carry 83,000 pounds of cargo, almost twice the load of the C-130, as well as up to 80 passengers, and a medical facility capable of transporting thirty-seven sick or injured with two nurses and three medical technicians. Plus, the Stratotanker can do much of this concurrently.

For example, this tanker can be loaded with U.S. Army troops headed from the United States to Germany. Then, while enroute, it can "drag" (refuel in flight) fighters or other cargo aircraft as they fly across distances that without the tanker would be impossible to cover, enabling those aircraft to complete their mission.

In March 2026, the Air Force used Stratotankers as air bridges across the ocean to enable rapid military buildup in the Middle East. Additionally, tankers can mitigate the negative logistical impacts that occur when other nations deny the right to land in, or fly over their countries, a situation the United States encountered with the onset of Operation Epic Fury.

It is our wealth of inflight refuelers —KC-135 R/Ts, KC-130Js, and KC-130Ts, plus the newest Boeing KC-46 Pegasus —that keeps us so highly mobile and makes our Expeditionary Forces rapid and agile. It is estimated that the United States possesses close to 75 percent of the world's aerial tankers. And as they say, "you can't kick a** without tanker gas."

GETTING THE GOODS TO HOSTILE AREAS

Spoofing and jamming, two forms of electronic warfare, have become commonplace in many regions across the globe. Spoofing is the deliberate, malicious broadcasting of false signals from the Global Navigation Satellite System (GNSS) or the Global Positioning System (GPS). Such nefarious interference is designed to deceive an aircraft's navigation systems, causing the aircrew to become uncertain of actual altitude, location, and time—information critical not only for mission success, but also for their survival.

Jamming of aircraft is the intentional disruption of GNSS/GPS signals, where powerful radio signals overwhelm

A C-17 Globemaster III assigned to the 62nd Airlift Wing takes off during exercise Kraken Reach 2026 at Joint Base Lewis-McChord, Washington, in January. The exercise focused on rapidly generating and launching multiple C-17 aircraft to test airlift readiness and response capabilities. (U.S. Air Force photo by Staff Sergeant Colleen Anthony.)

satellite navigation, causing navigation, timing, and automatic dependent surveillance-broadcast (ADS-B) surveillance systems to fail. Jamming drowns out legitimate signals, forcing pilots to rely on alternative systems or manual navigation.

FINDING THE WAY THROUGH THE FOG OF WAR

Safran Electronics & Defense, of Boulogne-Billancourt, France, recently partnered with U.S. Air Force C-17 operators to integrate and test its newest and most advanced inertial navigation systems (INS) tool, the experimental magnetic navigation (MagNav) technology. The goal was to provide a reliable, un-jammable alternative to GPS for military aircraft operating in contested or GPS-denied environments. Often referred to as “Mag in a Box,” the system uses highly sensitive magnetometers to measure the Earth’s magnetic field. These measurements are then compared to global magnetic maps to determine the aircraft’s precise location.

Safran Electronics & Defense incorporated into the MagNav system two of their core inertial navigation systems: Geonym and Sigma 95, both hybridized with magnetic data. This means that the material, data, or system is blended with magnetic properties, materials, or data structures to create a hybrid entity. In addition, Safran’s algorithms help filter out “noise”—vibrations and electromagnetic interference from the C-17’s systems—to ensure high accuracy.

C-130 Hercules operators can employ multiple redundant systems to navigate in contested or denied areas. One example, the Vision Aided Navigation System (VAN) produced by Honeywell Aerospace Technologies of Phoenix, Arizona, delivers robust navigation in GPS-denied environments by leveraging real-time image correlation against onboard reference maps. Functional day or night, the passive, sensor-agnostic solution enables accurate and reliable positioning across a wide range of environments and mission profiles.

Stratotankers operating in GPS-denied areas also need tools to stay on track. One method, the Resilient-Embedded GPS/INS (R-EGI), developed by Integrated Solutions for Systems (IS4S) of Huntsville, Alabama, provides secure, jam-resistant navigation using M-Code (the latest and most robust navigation and timing services of encrypted military GPS signals).

IS4S is partnering with Kearfott Corporation, of Black Mountain, North Carolina, in a $95 million contract awarded by the U.S. Air Force Life Cycle Management Center to devise the best ways to secure navigation in hostile environments. Kearfott produces two core components of the R-EGI system: a Safety Critical Navigation Processor and the Next Generation Inertial Measurement Unit (NxIMU), which measures a body’s specific force, angular rate, and sometimes the magnetic field.

CONNECTIVITY IN CONTESTED AIRSPACE

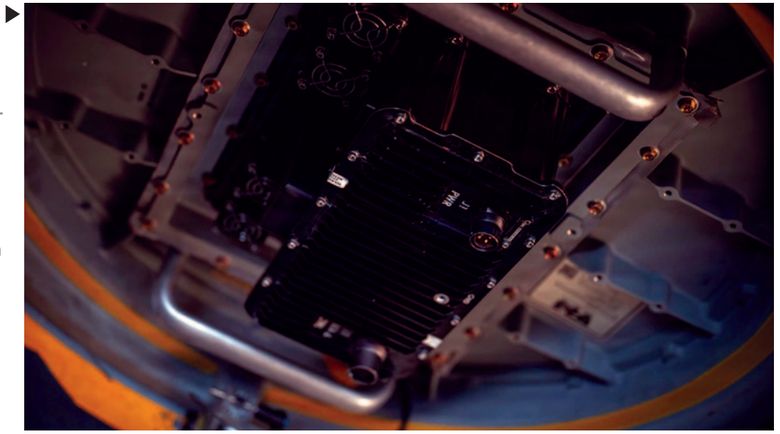
Communication is key for the successful interoperability of air assets. And aftermarket companies also are addressing the urgent need for secure communication systems free from interference and tampering.

Several manufacturers have produced roll-on/roll-off (RO/RO) antenna systems for the C-130J Super Hercules that feature satellite communications (SATCOM) or tactical networking. Space X of Hawthorne, California, produces a

The 39th Rescue Squadron conducted helicopter air-to-air refueling with a HH-60W Jolly Green II helicopter from the 305th Rescue Squadron over California in December 2025. (U.S. Air Force Photo by Staff Sergeant Nicole Mount.)

A C-130J Super Hercules assigned to the 36th Airlift Squadron lands on snow at Joint Base Elmendorf-Richardson, Alaska, in February 2026. Operating outside of a traditional runway setting, aircrews practiced delivering airlift capability in a contested environment. (U.S. Air Force photo by Senior Airman Cayla Hunt.)

An MC-130J Commando II, assigned to the Pennsylvania Air National Guard’s 193rd Special Operations Wing, prepares to receive fuel from a KC-135 Stratotanker from the 171st Air Refueling Wing over Coraopolis, Pennsylvania, in 2025. (U.S. Air National Guard photo by Shawn Monk.)



An R4i hatch-mounted Starshield Antenna communications system is installed aboard a U.S. Air Force C-130J Super Hercules assigned to the 36th Airlift Squadron, Yokota Air Base, Japan. The carry-on, carry-off system provides resilient, expeditionary connectivity in a contested training environment. (U.S. Air Force photo by Senior Airman Cayla Hunt.)

hatch-mount antenna that uses the Starlink constellation of satellites to provide secure, ultra-high-frequency, beyond-line-of-sight communications. Tested at Dyess Air Force Base, Texas, in summer 2025, the Starshield Mini hatch-mount antenna fits directly in an existing emergency escape hatch typically found on the top of the fuselage in the cargo compartment. Taking just 20 minutes to install, the antenna is part of a Joint Deployable Airborne Package that aims to enhance situational awareness for air and ground commanders in contested environments.

Viasat, of Carlsbad, California, also produces a hatch-mounted antenna. The VMT-1220HM provides high-speed Internet protocol (IP) connectivity to Ku-band (a microwave frequency segment of the electromagnetic spectrum, ranging from roughly 12 to 18 gigahertz, or GHz) satellite communications on the move. Using Viasat’s Yonder mobile broadband service, C-130 operators can send live, full-motion high-definition video over the horizon, make phone calls, conduct video conferences, access classified networks, and perform other mission-critical communications while in flight.

R4 Integration (R4), of Fort Walton Beach, Florida, is another provider of airborne roll-on/roll-off communication systems for the U.S. military. Utilizing the Milli SAT EX flat-panel antenna made by Get SAT of Rehevot, Israel, the R4 C-130 multi-purpose hatch system provides high-bandwidth Ka-band (a segment of the microwave spectrum within the electromagnetic field operating at frequencies between 26.5 and 40 GHz) connectivity for Special Operations. John Parsley, President of R4 states, “Our smart, integrated, hybrid solution meets the fast-changing intel requirements of airborne forces.”

BAE Systems’s Electronic Systems division, based in Nashua, New Hampshire, and Austin, Texas, is teaming up with KC-135 R/T units to re-purpose underwing multipoint refueling pods, once used for hose and drogue refueling, into High-Value Airborne Asset (HVAA) communication nodes. The HVAA pod integrates advanced data links such as Link 16 (a standardized communications system used by U.S., NATO, and Coalition forces) for transmitting and exchanging real-time tactical data using links between allied military network participants. One component of this system, the Advanced Survivability Pod (ASP), functions as a multi-spectral electronic warfare system that fuses traditionally separate data from various sensors that identify real-time threats and the need for countermeasures into an easily installed pod, providing one real-time operational picture.

When it comes to defeating the newly identified threats, the ASP activates an externally carried countermeasure, called the AN/ALE-55 Fiber-Optic Towed Decoy (FOTD), which lures radio-frequency–guided missiles away from the tanker. An internal radio frequency countermeasure (RFCM) system disrupts and “blinds” enemy radar systems, while a high-powered amplifier enhances the jamming signals to effectively counter advanced air-to-air and surface-to-air guided threats.

C-17 Globemasters also use secure satellite equipment, such as the JetWave MCX satellite communications system built by Honeywell Aerospace Technologies of Phoenix, Arizona. The system was specifically designed to provide high-speed, real-time situational awareness for defense aviation. In addition to its fast speed, the unit is capable of seamlessly switching between the Inmarsat’s Global Xpress (GX) network, the Wideband Global SATCOM Satellite (WGS, the backbone of the U.S. military’s wideband satellite communications), and other commercial and military Ka-band networks, solving problems that plagued earlier systems.

Thales Aerospace Communications of Rungis, France, is scheduled to complete the upgrade of 300 C-17s with the Aviator 700D Satcom system by the end of this year. The system, originally built by Cobham Aerospace Communications of Paris, France, was acquired by Thales in 2024. The device delivers global Inmarsat Aero H+ (a satellite communication service designed to enable voice calls, fax, and data transmission in flight) and SwiftBroadband (a top-mounted antenna communicating with Inmarsat-4 satellites that replaced slower systems and enables multiple, simultaneous users.)

ACHIEVING SITUATIONAL AWARENESS AMIDST THE CHAOS OF WAR

Today’s aerial battlefields are rife with areas of intense electromagnetic warfare that our Big Three must overcome to perform their global missions. When adversaries exploit the electromagnetic spectrum by interfering with navigational and communication data, our aircraft, crews, and the mission are in jeopardy.

This all underscores the importance of aftermarket companies teaming up with military developers to find ways to keep up with ever-changing threats. Together, they are shining a definitive light into the fog of war to achieve air superiority and ensure mission success.

AAD

The AN/ALE-55 fiber-optic towed decoy jams signals with a high-powered response from off-board the aircraft at the end of the towline. Missiles are guided safely away from the aircraft to the decoy. (Image courtesy of BAE Systems.)

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Skyryse received a UH-60 Black Hawk helicopter from the U.S. Army in summer 2025. In three months, they installed a new autonomous operating system and performed a flawless test flight. (Image courtesy of Skyryse.)

ADDING AUTONOMY

Making helicopters more independent is increasingly a choice with multiple options

By Jeff Blundell

Autonomy is coming to the world of military helicopters, of that there is no doubt. But how will this transition happen? One option, of course, is designing a purpose-built, fully autonomous rotorcraft. But that approach comes with an enormous price tag.

"It takes something like close to a billion dollars and many, many years to build a brand-new aircraft," says Sanjiv Singh, co-founder and Chief Executive Officer of Near Earth Autonomy. That is why decision makers in both the U.S. Army and the U.S. Marines have been considering an alternate approach.

"Why don't we use the aircraft we have today?" he has heard them say. "We already have the aircraft, and we have a whole operating and maintenance infrastructure to support them. We even have a supply chain for parts and everything else."

Singh's company, which is based in Pittsburgh, Pennsylvania, has spent the last 20 years working on developing such a solution for autonomous rotorcraft. That is, he and his team have designed the systems needed to retrofit existing rotorcraft platforms and convert them from piloted to self-flying.

"In 2010, the very first autonomous helicopter flight in the world was done by my group. That was a real landmark event. In 2017, we flew a Huey (Bell UH-1 Iroquois) for the Marine Corps autonomously. In 2021 we flew a (Kaman) K-MAX fully autonomously."

This past year saw another impressive first. Last May, Near Earth Autonomy successfully completed the first autonomous test flight of a Leonardo AW139 helicopter as part of the U.S. Marine Corps Aerial Logistics Connector (ALC) program. Next up is following through on a $15 million contract with the U.S. Army to retrofit Sikorsky UH-60L Black Hawks with advanced autonomy kits.

Singh explains, "This is a progression going from, 'Hey, can you do this at all?' To showing how these things can be super reliable. We're building a whole architecture of computing and sensors and algorithms."

Sanjiv Singh is co-founder and Chief Executive Officer of Near Earth Autonomy. He has a PhD in robotics from Carnegie Mellon University. (Image courtesy of Near Earth Autonomy.)

"The aircraft needs to be able to sense the world around it. And so, we have to give it some eyes."

NEW HARDWARE AND SOFTWARE REQUIRED

That's the "why." And proof that it can be done. The next question is how do you do it? The answer is through a combination of hardware and software adaptations.

The hardware component is heavily dependent on the age of the helicopter you are retrofitting. "When you have a legacy helicopter, in some cases, it has mechanical linkages," notes Singh. "So, what we have to do is put in parts that will accept computer commands."

If the aircraft already features fly-by-wire technology, then you are a step ahead. But there are still hardware additions required, specifically in the form of high-tech sensors. And sensor falls into two broad groups: intrinsic and extrinsic.

"Intrinsic is how the aircraft senses itself," says Singh. "Sensing pitch, roll, your position, and your orientation—all of that is the aircraft collecting data about itself. That is often already present on the modern helicopters."

"The extrinsic perception, which is awareness of the world around you, is almost never there." He adds, "The aircraft needs to be able to sense the world around it. And so, we have to

COMPARING THE CHALLENGES OF CONVERTING ROTORCRAFT VERSUS FIXED WING

A Robinson R-66 flying over the French Alps in February 2015. (Christian Arnal/Wikipedia)

Turning a helicopter into an autonomous flyer is very different than flying a fixed-wing aircraft without a pilot. Bryan Delia, Vice President of Sales for Skyryse, says that retrofitting planes is actually more straightforward than rotorcraft.

"There are differences in the flight control laws, because helicopters are inherently unstable," he says. Delia explains that the Skyryse team purposefully started with small helicopters, because they believe those are the hardest aircraft category in all of aviation.

"From the outside looking in, a lot of people might think because the Black Hawk is a significantly larger helicopter, that it would be more difficult for our automation system. But it was actually easier than a smaller helicopter like the R66. And then, when it comes to installing SkyOS on fixed-wing airplanes, like we did on the Cirrus SR22 in 2025, it was even easier.

Sanjiv Singh of Near Earth Autonomy explains that one reason working with planes is easier is due to where they fly. "If you are a fixed-wing aircraft, you're going to take off from a runway, and you're going to land on a runway," explains Singh. "You're not going to have a tree in the middle of your runway. So as long as you can come in from some distance into that runway, or depart along the runway, you're fine."

He continues, "Fixed-wing aircraft usually get up to some altitude and stay up there until they need to come down. The only thing you have to worry about is air traffic. But rotorcraft are designed to go from anywhere to anywhere. So, it may be that you're going somewhere where you've never been before. There may not be good maps of the location, you don't know what the terrain looks like, you're not guaranteed any good approaches."

The other consideration is that helicopters spend a lot of time flying at low elevation. "When you fly below 500 feet, it's much more likely that you'll get false positives from the terrain itself—something that looks like another aircraft. So, you have to be able to disambiguate the signals, because you're looking for small targets, both in the sky and on land."

Mission instructions can be sent to a U-Hawk helicopter by an operator on the ground using a tablet. (Image courtesy of Sikorsky/Lockheed Martin.)

give it some eyes." Along with that comes a need for the programming and computing power to enable the aircraft's systems to interpret what it sees.

When Singh talks about "sensing the world," he is referring to being able to detect, recognize, and interpret the size and position of buildings, towers, hills, trees, terrain, and other aircraft. There are three ways to do that.

"Generally speaking, we use some form of vision, like cameras," he starts. "They can be in different bands: visual or thermal. These are passive, meaning they don't transmit any energy. You use these cameras to collect video of what the aircraft is seeing and then analyze it. You say, 'that's a car, there's a person, there's a vehicle.'"

"The second thing we use is radar. Radar is well understood. You can use it to find targets and track them. With that, you're looking primarily for other aircraft. But there is also some new radar, which is called 'imaging radar.' This is brand new technology that uses radar wavelengths to be able to create an image. And that's really interesting, because at each point in that image, you also get a distance."

"Then we use LiDAR (light detection and ranging remote sensing). That's basically able to recreate a three-dimensional version of the world around the aircraft in great detail. So, we use a combination of these things, based on the tasks that these aircraft have to do."

Once those "eyes" are installed, Near Earth Autonomy needs to add some "ears", communication equipment, so that people on the ground can send instructions to the helicopter and also receive feedback. When all that is complete, you have a state-of-the-art machine that can sense its environment, know where it is in the world, and accept and carry out commands.

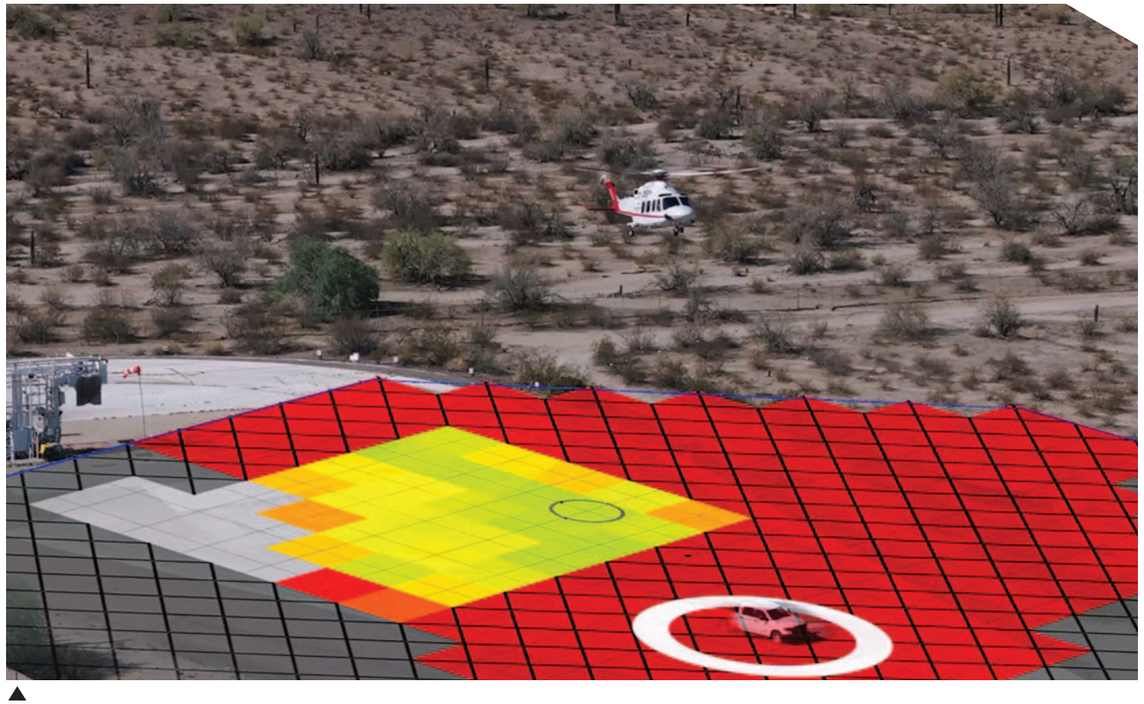
JUST HOW SMART?

The level of autonomy such aircraft can and will possess is an ongoing question. No one is suggesting—at least, not yet—that helicopters will be able to decide on their own to take off and go for a flight. But when a human decides a mission is needed, that person can program a destination and communicate the mission parameters to the helicopter, which can figure out the route.

"At the highest level, you want to say, 'Go here, go here, go here, go there,'" says Singh. "The flight instructions might also include a maximum elevation or some 'no-fly' areas. But from there, the helicopter will plan its own flightpath."

"That can be based on many things," he continues. "Maybe there are some buildings that we know about along the way that you have to route around. But what if there is a tower that was not on the map, but we discover it en route? In that case, the aircraft has to be able to make decisions and avoid those kinds of things and stay safe. Basically, what we have is a self-flying aircraft that can react to the reality of what's out there."

In May 2025, in Phoenix, Arizona, Near Earth Autonomy completed the first autonomous test flight of a Leonardo AW139 helicopter as part of the U.S. Marine Corps's Aerial Logistics Connector (ALC) program. (Image courtesy of Near Earth Autonomy.)



During a test flight, a truck was parked at the planned landing area. The autonomous AW139 helicopter detected the obstacle, and flew to an alternate landing area. (Image courtesy of Near Earth Autonomy.)

GOING INTO BATTLE

If an autonomous helicopter is going to operate in a contested airspace, it will need even more sensors. Equipment and programming will be needed that can both detect and recognize enemy forces and weapons. As for being an offensive force, that is another level all together.

"We are not thinking about weaponization right now for the aircraft to defend itself or anything else like that. That's just not in the scope of what we do," says Singh. But even existing in a theater of operations increases the challenges.

He points out, "In combat situations, to minimize vulnerability, you have to fly really low, low enough that radar can't detect the aircraft. What's interesting about that is that now, you have to be really aware of the environment. If you fly at 2,000 feet, there's almost nothing there. But if you're flying at 300 feet, the undulation of the terrain matters, and you have to be able to sense that environment." That is just one of the reasons it might be a while before we see combat-ready helicopters in active service without a pilot.

SKY IS THE LIMIT (BLACK HAWK)

Skyryse is another company working in this space. But rather than replace the pilot, they are developing incremental technologies that assist with and streamline the flight crew's workload. Their operating system is called "SkyOS."

"SkyOS is always-on automation in service of the pilot," says Bryan Delia, Vice President of Sales for Skyryse. "It makes flying in all circumstances, including emergency situations, simpler and safer." The result is a human–machine hybrid operation.

"By design, SkyOS blends the most advanced automation and the best of human decision making to improve safety and mission effectiveness. And we believe that is the most imperative, engineering challenge of our time," says Delia.

This approach is appealing, in part, because it mimics what we are seeing on the road. Very few drivers are ready to cede 100 percent of their decisions over to an autonomous car. Yet most of us are becoming comfortable with features such as adaptive cruise control, lane detection, automatic breaking, and self parking. These features do not replace you. They just make your daily commute easier and safer.

SkyOS software handles tasks considerably more complicated than parallel parking a hatchback. According to Delia, "Leveraging automation to reduce pilot workload is our focus, and there is no doubt that reducing workload during emergencies is critical. But we also find that reducing workload during routine tasks can make pilots more effective, by freeing time to devote to planning the next steps in the flight profile and evaluating potential options for the next phases of the flight."

"To date, we've achieved several first-ever aviation feats with SkyOS," he notes. "These include not only routine tasks like engine startup, but also challenging, critical tasks like engine-out landings (autorotations)."

Skyryse's latest milestone flight happened in late 2025. A UH-60 Black Hawk Helicopter, equipped with SkyOS, successfully executed an automated pickup, stable hover, and other precision flight maneuvers. Eric Stierna, a retired army pilot with extensive experience in the Black Hawk, was the test pilot on board for the first flight.

"Flying with SkyOS is truly a game changer," Stierna states. "I swiped my finger and climbed into a completely stable hover. I swiped again and descended into a perfect set down." The test flight was short and successful. And the process of getting there was surprisingly brief.

"Typically, in this industry, technology integration to flight testing takes months, years, and, in some cases, decades," says Delia. "But for us, we took the same technology that's been flying on our Robinson R66 platform and successfully flew with SkyOS in our Black Hawk just 91 days after integration began. That timeline demonstrates the maturity, transferability, and scalability of the SkyOS system on any aircraft."

A 3-month turnaround to adapt such a significant upgrade is virtually unheard of in the industry. It reflects the 10 years of work Skyryse has done to make SkyOS "platform agnostic." It was also possible because the Black Hawk platform is so thoroughly understood. "This retrofit approach is much faster than a clean sheet design of a fully autonomous helicopter," notes Delia.

He adds that the U.S. Army usage profile is well suited for an optionally piloted platform, because the service requires so much flexibility in how its

Bryan Delia is the Vice President of Sales at Skyryse. (Image courtesy of Skyryse.)

> **"By design, SkyOS blends the most advanced automation and the best of human decision making to improve safety and mission effectiveness.**

Top to bottom:
Rotor Technologies chose the popular Robinson R44 as its primary platform. They sell a retrofit package to convert this helicopter to an autonomous aircraft.

Rotor Technologies converts Robinson R44 helicopters to self-flying rotorcraft, renaming them, according to their intended use, as R550 Airtrucks or R550 Sprayhawks.

As part of the retrofit process, Rotor Technologies removes the seats and the manual controls, allowing for greatly increased cargo space.

(All images on this page courtesy of Rotor Technologies.)

The R550 can perform long monotonous crop-spraying operations in a set pattern without ever losing focus.

assets are utilized. "Whether the mission calls for a flight that is single-piloted, dual-piloted, or uncrewed and operated from a ground station, a Black Hawk with SkyOS is capable of adapting across all mission profiles."

"SkyOS is available now, and the Black Hawk is one of the most capable and prolific helicopters to exist. By focusing our energy on modernizing existing aircraft, we're offering customers, including the U.S. Army, advanced technology and enhanced capabilities for an aircraft they already trust and use," Delia concludes.

DULL, DIRTY, AND DANGEROUS

Even though ROTOR Technologies has only been around for five years, the company is in some ways ahead in this field, perhaps because their goals have been more modest. They already have unmanned helicopters working for civilian companies. "We build autonomous and unmanned technology for today," explains Nik Coates, Vice President of Partnerships at ROTOR.

Their approach is straightforward and practical. What they do is take Robinson R44 helicopters—a well known, commonly used civilian helicopter—and offer a retrofit package. For just under $200,000, they can update the hardware and install the software to make it an unmanned craft. The resulting airframe still has all the range and capabilities of the crewed version, but you do not have to put a person in the pilot's seat.

"Our focus is really what we call dull, dirty, dangerous missions," says Coates. "So, things like agriculture, cargo carrying over the ocean, emergency response, search and rescue, and firefighting eventually as well."

You might not think that agriculture work is especially dangerous. But Coates explains that spraying crops required helicopters to fly very close to the

Part of the retrofit process is to add new sensors to the helicopter to give it independent awareness of its surroundings. (Image courtesy of Rotor Technologies.)

ground. As a result, agricultural pilots face the constant threat of hitting electrical wires.

"It's not that they don't know where the wire is," he explains. "They know where the wire is, but they've been flying for 10 hours, and if you're doing anything for 10 hours, you aren't going to be at your best. What this system does is keep the pilot fresh by allowing the computer and the systems to do more of the work."

The other safety feature is that the pilot is not actually in the aircraft. Helicopters with the ROTOR retrofit are flown by a pilot sitting in a ground control station. They have screens and control levers that mimic the in-craft experience. There is even a microphone on board and a speaker in the control station, so the pilot can hear the engines. From there, he or she controls take offs, landings, and other complicated maneuvers.

For the majority of the flight, the pilot's input is not needed. The system is designed to fly from waypoint to waypoint for most of its route. Collision avoidance technology helps keep it safe along the way, but otherwise it just flies a pre-programmed route. In the case of agricultural work, that means back and forth across a massive field. For cargo delivery, the aircraft might fly a straight route over the water to an offshore oil rig. As it approaches the landing site, a human pilot on the platform can take over control and land the helicopter.

The ROTOR system provides the user with a full-sized helicopter that can be controlled as easily as a tiny drone. It is not surprising that its low-cost and reliable technology has caught the attention of the military.

"Yeah, we get lots of phone calls. In terms of military uses, we're focused on research and development, things like payload carrying for testing. We get

Nik Coates is the Vice President of Partnerships at Rotor Technologies. (Image courtesy of Rotor Technologies.)

"Our focus is really what we call dull, dirty, dangerous missions,"

THE U-HAWK

Because there is no need for a pilot's seat or windshield, the entire front section of the U-Hawk helicopter is available as a cargo hold, complete with clamshell doors. (Image courtesy of Sikorsky/Lockheed Martin.)

The advantages of retrofitting existing helicopters are well documented. Still, it is hard to beat the upside potential of designing something from scratch. That is why Sikorsky is introducing the S-70UAS U-Hawk, a fully autonomous helicopter built on the principles of the traditional Black Hawk, but designed to integrate autonomous control from the start.

For instance, the designers decided that once a Black Hawk becomes autonomous, the pilot seats become wasted space. The windows, instead of being essential, are an unnecessary weakness. And creature comforts added to accommodate human beings are just extra weight.

Eliminating the cockpit gives the U-Hawk 25 percent more cargo space. That capacity, combined with the clamshell doors on the nose, will enable this capable rotorcraft to carry and deploy larger equipment such as a HIMARS (High Mobility Artillery Rocket System) rocket pod, unmanned ground vehicles, or up to 10,000 pounds of supplies.

The mission will be initiated by a single operator using a tablet. Then, onboard systems will take over to execute that mission. The U-Hawk can be flown solo, in a fleet of other U-Hawks, or in conjunction with piloted Black Hawks.

In terms of structural and mechanical components, Sikorsky claims the U-Hawk design has 95 percent commonality with the manned UH-60 fleet. This will greatly simplify maintenance and sustainment.

This impressive workhorse is on a rapid development schedule, having progressed from concept to reality in just ten months. At the time of this writing, it was on a fast track for its first flight sometime this year.

The U-Hawk's array of sensors allows it to operate in complete darkness. (Image courtesy of Sikorsky/Lockheed Martin.)

"SkyOS blends the most advanced automation and the best of human decision making to improve safety and mission effectiveness," says Bryan Delia of Skyryse. (Image courtesy of Skyryse.)

calls saying, 'Can you carry this sensor? We need to fly it over the ocean to see if it works.' And our answer is, 'Yeah, we're happy to do that.'" We just really want to build a great product that's going to improve people's lives."

WHAT'S NEXT?

It's possible that one of those options—fully autonomous, human/computer hybrid, or remote controlled—will win out in the end. Or it could be that the military decides to go all in on a new platform (*see the sidebar about the U-Hawk project*). But most likely, all three options will find a home. Different users with different needs and different budgets will prioritize different capabilities.

Whichever route they choose, the goal will be the same: keep pilots safe and make them even more effective at their job.

AAD

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Skyryse test pilot Eric Stierna says, "We knew we were experiencing something completely new." (Image courtesy of Skyryse.)

(Image courtesy Elbit Systems of America.)

Luke Savoie
President and CEO
Elbit Systems of America

Movers & Shakers

Exceptional People Helping To Shape The Future

SPOTLIGHT ON

Luke Savoie

President and CEO, Elbit Systems of America

By Andrea Templeton

Long before Luke Savoie ever flew a military aircraft, he understood the aftermarket. Growing up in Michigan in a household shaped by the rhythms of manufacturing, family conversations often centered on supply chain challenges. His father worked for General Motors, and the urgency of keeping a production line running, including moving parts overnight across state lines to prevent a shutdown in Kokomo or Flint, was ingrained in daily life.

“My dad was a parts guy, basically,” Savoie recalls. “Kitchen table talk was about not letting a line stop, and the logistics of leasing aircraft overnight to move parts fast. That was the environment I grew up in.” In 1988, his father’s GM career took the family to South Texas to support operations in Mexico. A front-row seat to the NAFTA era expanded those conversations to include cross-border sourcing and the dependencies that hold industrial systems together.

Early on, Savoie developed a fascination with aviation. As a child, he transformed his parents’ stereo into an imaginary cockpit control panel—no simulators, no computers, just switches and a vivid imagination.

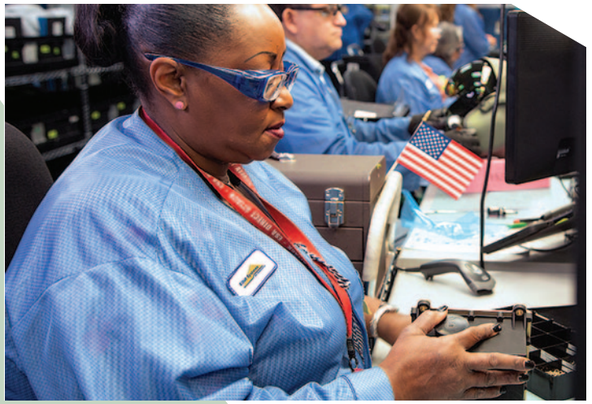
LESSONS LEARNED AT ALTITUDE

That fascination led him to the U.S. Air Force Academy, where he graduated into an era transitioning from post–Cold War drawdown to post–9/11 operational tempo. He logged ten deployments spanning Afghanistan, Iraq, and North Africa.

The aircraft Savoie flew were, almost by definition, aftermarket platforms. The Lockheed AC-130, which he flew as a gunship, began its life as a cargo aircraft before being transformed into a heavily armed platform by contractors. “It’s an inherently aftermarket mod,” he says. “Not even the OEM (original equipment manufacturer) of the plane did the modifications that made it into what it was.”

The U-28A’s modifications went further still. A Swiss-made commercial turboprop, it was repurposed as a classified special operations intelligence platform. When operations necessitated a cockpit upgrade, Savoie tracked down a small Idaho company with an FAA-certified glass cockpit display built for

(Image courtesy Elbit Systems of America.)



An F-35 pilot carries the aircraft's helmet-mounted display system, which serves as the jet's primary flight instrument, projecting flight data and sensor feeds directly into the pilot's visor. Elbit Systems of America supports sustainment of the system across the U.S. Air Force, U.S. Marine Corps, and U.S. Navy fleets. (U.S. Department of Defense photo.)

Top Left Image:
Technicians assemble avionics components at Elbit Systems of America's Fort Worth, Texas, facility—the same site where F-16 avionics were originally designed and produced under General Dynamics.

Bottom Left Image:
Elbit Systems of America employees at the company's Fort Worth manufacturing facility. Savoie describes the connection between the factory floor and the warfighter as central to the company's mission—a philosophy reflected in a workforce with deep roots in military service.

Right Image:
At Elbit Systems of America's Fort Worth manufacturing facility, a technician performs detailed precision work on defense components. The company's workforce—a significant portion of whom are veterans—brings both technical expertise and a firsthand understanding of the mission to every task.

(All images on this page courtesy Elbit Systems of America.)

the commercial Pilatus PC-12 market. Watching a vendor demonstration of a monitor featuring a standard digital visual interface (DVI) connector, he realized, "I can just drive that display with a regular computer."

Within six months, twelve aircraft had been retrofitted. Velcroed laptops and dashboard-mounted screens were gone, and mission sensor feeds were moved from the back of the aircraft to the glass in front of the pilots. The total cost? Approximately $250,000.

Savoie distills it simply, "You work backward from the mission. What do you want the user experience to be?" His team was awarded the Colonel Joseph B. Duckworth Annual U.S. Air Force Instrument Award for their contribution in 2009.

This was a hands-on lesson: impactful innovations are often not new platforms, but smarter uses of existing ones. This shaped Savoie's decision in 2009 to leave the U.S. Air Force for industry. He notes, "I figured I could make more of an immediate impact by being in industry than by following the normal progression of a military career."

SUSTAINMENT BY DESIGN

After tenures at Sierra Nevada Corporation and then L3 Technologies, where he managed a $3.5 billion portfolio of missionized aircraft, Savoie assumed the top role at Elbit Systems of America in early 2024. Elbit America traces its founding to the acquisition of General Dynamics's electronics facility in Fort Worth, where Lockheed Martin F-16 avionics were designed and produced. Some of the original General Dynamics test equipment from that time, Savoie notes, is still in use on the Fort Worth floor today, oversized floppy disks and all, alongside modern production lines.

"Our origin story is really around F-16 sustainment," he explains. "The model was: our affiliate sells content into OEMs, and we sustain that content in the aftermarket—directly with the U.S. government, or with the OEMs themselves." He continues, "You have to understand what your customer actually cares about. A lot of times, it's the sustainment aspects that win the day."

That model has expanded to include Boeing AH-64 Apache helicopter sustainment. Elbit America has produced the monocular display integrated into the pilot's helmet since the 1980s. More recently, the company added joint production and sustainment of the Lockheed Martin F-35's helmet-mounted display system. That helmet is the aircraft's primary flight instrument, projecting flight data and sensor feeds directly into the pilot's visor.

"It's like taking the dashboard off the plane and putting it on your helmet and then walking it back to your locker every day," Savoie says. The wear, environmental stress, and precision required to keep the system operational make it a substantial sustainment undertaking across the U.S. Air Force, U.S. Marine Corps, and U.S. Navy fleets that fly the F-35.

CLOSER TO THE MISSION

The Apache program illustrates a different kind of aftermarket challenge, bureaucratic. The U.S. Army had used the same monocular helmet display for so long that the certification machinery had lost its own trail. There was no institutional memory of how the system originally was approved and no clear path for how best to upgrade it.

Elbit America's solution was to design a replacement identical on every metric the certification process cared about: same weight, same symbology, same legacy hardware interface. The new display also supports color imagery, binocular projection, embedded night vision, and manned-unmanned teaming—added capabilities the U.S. Army did not have to certify because they were not the basis of the purchase.

Savoie discusses how Elbit Systems of America maintains a real-time operational feedback loop that informs that understanding of mission needs. As an example, through its relationship with the Israeli affiliate, the company has access to F-35 pilots currently flying combat missions in the Israeli Air Force. "We have employees who are F-35 pilots in the Israeli Air Force," Savoie says. "They go into contested airspace, and we're in their combat debriefs, getting real-time feedback on how the systems work and how to improve them. That's a feedback loop that others don't have domestically."

"When you're in a board meeting and every board member, every C-suite executive, including the HR person, is a

Top Left Image:
A U.S. Army AH-64 Apache attack helicopter in low-level flight during a training exercise. Elbit Systems of America has supplied the monocular display integrated into the Apache pilot's helmet since the early 2000s and recently delivered a next-generation replacement, adding color imagery, binocular projection, and manned–unmanned teaming capability. (U.S. Army photo.)

Bottom Left Image:
The Boeing AH-64 Apache remains one of the U.S. Army's most critical rotary-wing assets. As the Army adds new weapons and processing requirements, Savoie sees the Apache's continuing evolution as among the most significant near-term opportunities in defense aftermarket. (U.S. Army photo via DVIDS.)

Right Image:
A rendering of the modernized AH-64 Apache cockpit displays Elbit Systems of America's digital avionics suite, integrating targeting video, moving map navigation, and mission data into a streamlined crew interface. (Image courtesy of Elbit Systems of America.)

veteran, you can't help but feel the mission-oriented aspect of it." He sees that culture as increasingly aligned with the direction of U.S. defense leadership, which has made deepening its partnership with industry a stated priority.

"The mindset is that industry should care about the warfighter the same way the warfighter cares about the mission, and both should succeed, on the battlefield and on the balance sheet."

THE CHALLENGE AHEAD

Savoie is clear-eyed about the strategic context driving demand. A potential large-scale peer conflict is fundamentally an aftermarket problem.

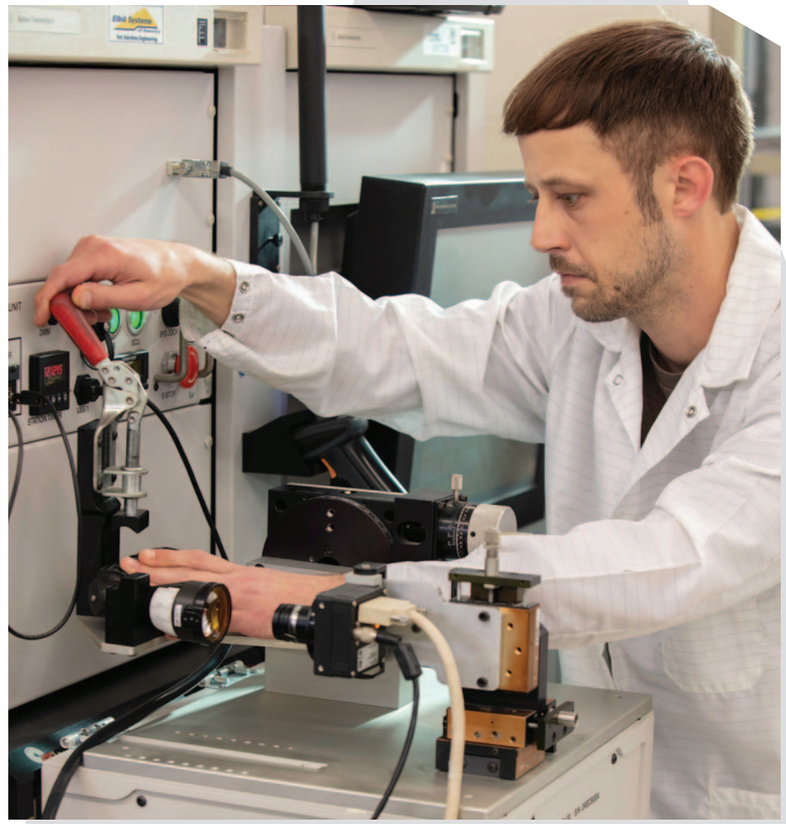
"If you're going to fight a near-peer conflict in 2028, it is solely an aftermarket game," he says. "What can you upgrade? What can you make better with what you've got today? Because that's what you're going to have."

That scenario also raises questions the military is only beginning to address. If major portions of the Pacific become denied airspace, the standard logistics model—remove broken components, ship them stateside for depot-level repair, return them to theater—may not function.

"I started asking questions of the military. For instance, are you planning on very large ships that can do electronic component repair forward?" Savoie says. "Because I don't know how you think you're getting this stuff back to the States if the Pacific Ocean is denied airspace." Elbit America operates a sub-component repair capability that could, in theory, be deployed in forward operations. This approach would enable repair of critical avionics closer to the battlefield. The question is how to structure and fund that kind of distributed repair capability.

The same logic extends beyond

Engineers at Elbit Systems of America's Talladega, Alabama, facility. The site supports radar and electronic systems work aligned with the company's strategy of vertical integration, bringing critical sub-component production in-house to reduce dependence on commercial supply chains. (Images courtesy Elbit Systems of America.)



maintenance. If future conflicts depend on sustaining and upgrading existing systems in contested environments, supply chain reliability becomes just as critical. As much of the aviation supply chain relies on suppliers whose primary markets are commercial rather than military, defense demands compete with larger commercial production cycles. According to Savoie, "If someone has commercial interests outside the Department of War, they're not going to prioritize you."

One response has been increased vertical integration, bringing capabilities such as surface-mount circuit card production in-house to reduce reliance on outside vendors and ensure critical components remain available. As these systems grow more operationally and industrially complex, new tools are emerging to manage that complexity.

Savoie sees artificial intelligence as a force multiplier, not a replacement for human judgment. "AI isn't going to replace a program manager," he says. "It's going to allow a program manager to manage five programs. Less time in a spreadsheet, more time making decisions with the data and having the right conversations." As AI absorbs analytical workloads, he predicts the premium will shift to people who can read a room, build trust, and turn data into decisions that stick. The skills that matter most are the ones that cannot be automated.

WHAT THE USER NEEDS

Savoie identifies the rotary-wing domain as the area of greatest near-term aftermarket opportunity: the emerging Bell MV-75 program, the Boeing AH-64's continuing evolution as the U.S. Army adds new weapons and processing requirements, and the sustained effort to keep the Sikorsky UH-60 Black Hawk operationally relevant beyond its original design parameters. As these platforms will not be replaced in near-term budget cycles, their future is in the hands of the aftermarket.

Savoie describes his motivation in terms that have remained consistent from his first deployment to his current role: staying in the fight and looking after the people who are in it. "Being so close to the mission, everything you did mattered," he says of his years flying for the U.S. Special Operations Command. "I got into industry to maintain that feeling."

Asked to characterize the essential insight behind what his company does, he returns to a principle that has guided his career. "The biggest thing in the aftermarket is understanding the present-day use case," he says. "Work backwards from what the user actually needs. Know the workflow. Everything else follows from that."

AAD

The first "production representative" B-21 Raider bomber conducting flight tests, which include ground testing, taxiing, and flying operations, at Edwards Air Force Base, California, in January 2024. (U.S. Air Force Photo by Giancarlo Casem, 412th Test Wing.)

THE NEW WAY TOWARD

FASTER, CHEAPER, BETTER

Northrop Grumman's B-21 Raider is part of a revolution in manufacturing dynamics

By Terry Lloyd

When the first B-21 Raider emerged from a hangar in Palmdale, California, in late 2022, those in defense aviation world saw not only the first true sixth-generation aircraft, they also saw a new cornerstone of the U.S. Air Force's strategic nuclear modernization. At the same time, Northrop Grumman's B-21 program typifies state-of-the art aerospace manufacturing dynamics, integrated software deployment and certification, and dynamic production methodologies that are revolutionizing the industry.

At the unveiling of this new stealth bomber, Northrop Chief Executive Officer Kathy Warden stated that the B-21 was designed with modular, open-systems architecture to enable easy upgrades. This also facilitates exports to foreign buyers, such as Australia, which has not had a long-range strike capability since retiring its fleet of General Dynamic F-111s in 2010.

The B-21 is notably the first combat aircraft to be built from the ground up as a fully digital, software-centric, and continuously upgradable weapons system. From concept to flying prototype, its development has been shaped by model-based systems engineering (MBSE), digital twins, automated composite fabrication, and quality assurance driven by artificial intelligence and advanced robotics (AI/AR). These optimized methods resulted in a first test aircraft that flew in November 2023 with a level of maturity normally associated with late-stage production models.

The approach to creating this new model has not been confined to this one project, nor has it been incremental. New methodologies are being adopted across the defense aerospace industry. Akin to the groundbreaking implementation of the automobile factory assembly line in the early 1900s, this shift is reshaping how the U.S. and other nations will build fighters, drones, and space systems in the decades to come.

With digital engineering forming the primary design environment, the B-21 has evolved inside a single, unified digital ecosystem.

WHAT'S INSIDE MATTERS

While the new bomber's airframe is the most visible part of the story, the real transformation lies in the underlying invisible layers. With digital engineering forming the primary design environment, the B-21 has evolved inside a single, unified digital ecosystem.

Full fidelity digital twins have been used for every subsystem, from structural spars to mission systems. Physics-based simulations have determined and verified thermal loads, radar cross sections, electromagnetic compatibility, and structural fatigue parameters. Automated design rule enforcement has eliminated thousands of hours of manual checks. And both now and going forward, software-defined avionics enable rapid reconfiguration without hardware redesign.

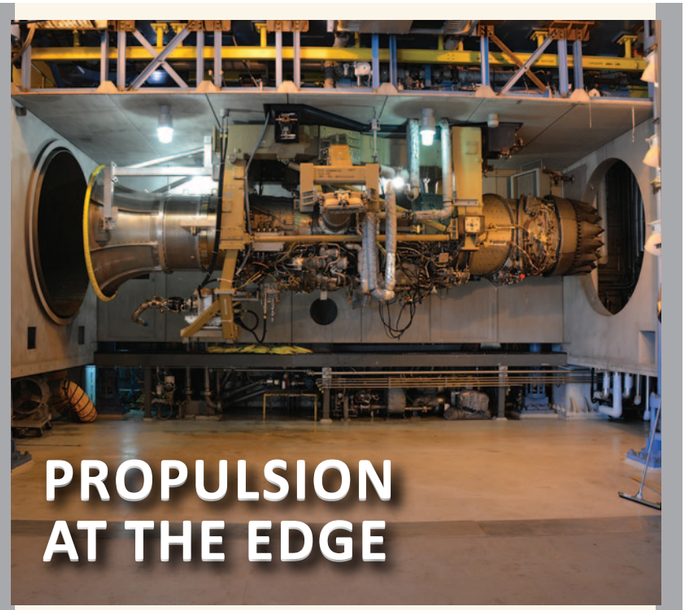
The B-21 incorporates two basic design concepts. The first is overarching weight reduction, achieving lower fuel consumption and greater range. Monolithic composite sections minimize seams and fasteners and reduce weight, radar signature, and ultimately maintenance. Utilized at an unprecedented scale throughout the aircraft, these composite structures are made by automated fiber placement machines—examples of advanced robotics—that lay down carbon fiber tapes with micron-level precision and use high-temperature resins for tighter thermal tolerances. Additively manufactured titanium fittings are bonded into the composite structures, reducing both weight and the parts count.

The second design focus is on multispectral stealth, with the goal of making the aircraft invisible across all detection methods. Radar, infrared (IR), acoustic, and electronic signatures are all suppressed.

While developments such as photonic radar, incorporating lasers along with traditional radar, may defeat current radar absorbent material (RAM), newer RAM is more durable, easier to maintain, and more effective. Engine/duct designs and materials aim to match exhaust to ambient air temperature to reduce IR detection. Embedded conformal antennas are laminated into composite skins to eliminate protrusions, a major challenge to stealth design. Lower emissions and a "whisper quiet" electronic signature further thwart detection methods.

In terms of the build, application of these new processes and use of advanced materials require exceptional quality control. The B-21's production line integrates a number of dynamic AI-driven quality control innovations. For critical composite layups, machine vision inspection uses industrial cameras, lenses, and lighting to perform rapid automated imaging and inspection of every part or surface.

Ultrasonic and thermographic nondestructive inspection (NDI), automated by AI classification algorithms, along with predictive defect modeling, enable technicians to correct issues before they propagate. This is a radical departure from legacy stealth programs, where manual inspection dominated and the need for rework was common.



PROPULSION AT THE EDGE

The F135 engine is likely the basis for new adaptive cycle engines to be produced using advanced design, materials, and manufacturing methods. (Photo courtesy of the U.S. Air Force.)

Even though there are two B-21s flying, little is officially known about the B-21's twin engines, except for Pratt & Whitney being named as the manufacturer. There is widespread industry speculation that what powers the Raider is a derivative of the F-35 Lighting II's F135 engine. In the future, it is likely that General Electric will also be a key player in developing engines for the new generation of military aircraft.

The next generation of propulsion for military aircraft like the B-21 and the F-47 is being shaped by the concept of adaptive cycle engines capable of shifting between high-thrust and high-efficiency modes on demand. Potentially such a design promises 25 to 30 percent better fuel efficiency, more than 10 percent added thrust, and dramatically improved thermal management for high-power sensors and directed-energy weapons.

Technologies such as three-stream architecture—having a third bypass stream that can be opened or closed to optimize thrust or fuel burn—are examples of how additive manufacturing allows designers to incorporate complex cooling channels and lightweight structures that cannot be machined conventionally. The use of ceramic matrix composites enables turbine blades and shrouds to endure temperatures hundreds of degrees hotter than current metal alloys. And digital engine twins are real-time models that can be used to calculate wear, thermal cycles, and performance degradation, informing maintenance and logistics decisions.

While further details were not yet unveiled at the time of this writing, such high-tech approaches and materials are likely to form the engines that power the F-47 and future Collaborative Combat Aircraft unmanned variants requiring long endurance or high-thrust dash capability.

A second B-21 Raider, the world's first sixth-generation stealth bomber, arrived at Edwards Air Force Base, California, on September 11, 2025. (U.S. Air Force Photo, courtesy of the 412th Test Wing.)

The B-21 is the first bomber designed to evolve at software speed. Unlike earlier programs, its test prototype, referred to as the Production Representative Test Aircraft, is built on the same line with the same tooling that will be used for operational jets. This eliminates the "prototype gap" prevalent in previous aircraft development.

Software certification was a major challenge in upgrading Block 4 F-35s, with deliveries of new aircraft stalled out for over a year in 2023–2024. With Cloud Native Software Development, the mission systems, electronic warfare (EW) suites, and flight software are more efficiently updated. Containerized software modules provide a standardized and efficient way to package applications.

Continuous integration/continuous delivery and deployment (CI/CD2) maintain software code integrity across the deployment process. CI automatically and frequently integrates code changes into a shared source code repository, ensuring that all developers are working on the same codebase (figuratively "the same page") and any conflicts are identified and quickly resolved. Continuous delivery (CD) automates the delivery of code changes to a staging environment for testing, confirming the code is in a deployable state. Continuous deployment (CD) is a more advanced practice, whereby code changes are automatically released to production without manual intervention, providing faster, more frequent updates to end users.

Other innovations enable greater reliability in the software/hardware interface environment. Hardware in the loop (HIL) simulation is a technique used in the development and testing of complex real-time embedded systems. A virtual "electronic test bench" inserts realistic inputs into the simulation and returns feedback from downstream systems and components. Similarly, digital threat environments are used for testing EW and vital autonomy algorithms.

At the time of this writing, two "production representative" B-21s had been delivered to the U.S. Air Force Plant 42 in Palmdale, California, the most recent this past September. Early this year, a U.S. Air Force press release announced authorization of an additional $4.5 billion to increase the B-21 annual production capacity rate by 25 percent, compressing delivery timelines.

"This decision reflects our confidence in the program's performance and the stability of the industrial base. By increasing

The B-21's production line integrates a number of dynamic AI-driven quality control innovations.

CCA WINGMEN INNOVATORS

A U.S. Marine Corps XQ-58A Valkyrie uncrewed Collaborative Combat Aircraft (CCA) seen in flight testing with two U.S. Air Force F-35A Lightning IIs in 2023. The XQ-58A Valkyrie is expected to become the first operational CCA in use by the U.S. military, though the Royal Australian Air Force's Boeing MQ-28 Ghost Bat is reportedly closer to operational deployment. CCAs must be as "stealthy" as the crewed aircraft they accompany. (U.S. Air Force photo by Master Sergeant John McRell.)

The Collaborative Combat Aircraft (CCA) program is where the B-21's digital legacy appears most visible in terms of digital engineering and low-cost manufacturing. Flying with Gen 5 and 6 crewed combat aircraft will require any unmanned CCA to have similar stealth capabilities and to be developed and produced similarly to the crewed aircraft.

Unlike the B-21, however, such drones are considered "attritable," so they must be relatively inexpensive to produce. They also need to be adaptable. Almost all CCA design requirements dictate modular construction to enable rapid mission reconfiguration, including electronic warfare, sensing, strike missions, or even launching secondary drones.

The Boeing MQ-28 Ghost Bat was developed in Australia as a loyal wingman platform. It is currently at the forefront of CCA implementation among the world's air forces.

Kratos Defense & Security Solutions, teaming with Northrop Grumman, was awarded the U.S. Marine Corps' Marine Air-Ground Task Force Uncrewed Expeditionary Tactical Aircraft (MUX TACAIR) CCA contract in January. This project puts the Marine Corps next in line to become operational.

Audril and General Atomics Aeronautical Systems are in competition for the U.S. Air Force's CCA program. General Atomics's YFQ-42A made its first flight last August, while Anduril's YFQ-44A first flew in October.

The United Kingdom's Ministry of Defense initiated Project NYX in January 2026 by inviting seven firms — Anduril, BAE Systems, Leonardo, Lockheed Martin UK, Syos, Tekever, and Thales — to submit designs for Autonomous Collaborative Platforms (ACP)/Uncrewed Air Systems (UASs) to serve as "loyal wingmen" alongside the British Army's AH-64 Apache attack helicopters. The ACP/UAS plans to begin initial operations by 2030. The U.S. Army has also expressed interest in the development of CCAs for use with helicopters.

The clearest available indication of how and to what extent CCAs will be employed comes from comments by Lockheed Martin CEO Jim Taiclet at a recent defense forum. He remarked that he had observed a U.S. Air Force general officer in an F-35 simulator controlling eight CCAs at once, using his tablet "kneeboard," all while still "flying the aircraft."

The design and production of CCAs is both a linear drone program and part of a software-first, autonomy-driven manufacturing revolution. Together, these companies are defining the future of manned-unmanned teaming.

This graphical artist rendering, released in March 2025, shows the U.S. Air Force's sixth-generation fighter, the F-47, the result of the Next Generation Air Dominance (NGAD) Platform program. Intended to replace the F-22 and feature advanced stealth and sensor capabilities, it will likely take on intelligence, surveillance, and reconnaissance and strike management "quarterbacking" roles. (Image courtesy of the U.S. Air Force.)

production capacity now, we are responsibly accelerating delivery of a critical, combat-effective capability to the warfighter," stated General Dale R. White, Director, Critical Major Weapon Systems.

Various air power studies have called for a minimum of 200 B-21s to confront future threats. At this time, however, there has been no further word on acquiring additional B-21s beyond the minimum of 100 aircraft in the current program.

THE RIPPLE EFFECT

Boeing's development program for the F-47 next-generation air dominance platform uses the same digital engineering principles first developed for B-21 production. The process directly supports the U.S. Air Force's goal to compress fighter development cycles from decades to single-digit years.

These principles include parametric design tools to assist designers in creating complex and adaptive forms and structures that can dynamically adjust based on aerodynamic input parameters. This eliminates unstealthy "bumps and bulges" seen on aircraft when a component just could not be made to fit within the aerodynamic envelope of its structure.

Modular open systems architecture (MOSA) accommodates plug-and-play sensors and weapons to ease upgrades. And additive manufacturing of load-bearing titanium components, where a component is 3D printed one layer at a time using titanium wire, eliminates waste of this valuable material typical of traditional forging and milling.

Both Boeing and the U.S. Air Force seem to agree that, like the B-21 Raider, a production representative F-47 first aircraft can be made available for testing within the next two years. "People will be surprised by how fast you see [the F-47] flying, I think it'll happen faster than normal," Colin Miller, Vice President and General Manager at Boeing Phantom Works, commented during a fireside chat at the National Defense Industrial Association's Emerging Technologies for Defense Conference last August.

In September, General David Allvin, then U.S. Air Force Chief of Staff, was more specific. He informed the audience at the U.S. Air & Space Forces Association's Air, Space and Cyber Conference that the first F-47 is being manufactured and is expected to fly in 2028.

To date, the F-47 program is funded at $2.6 billion in fiscal year 2026, with $972 million in research-and-development funds for the corresponding Gen 6 Navy F/A-XX fighter-attack aircraft program. While Boeing now has the F-47 program, B-21

"We are investing to bring advanced capabilities from our 6th Gen work to enhance the relevance and capability of the F-35."

A Lockheed Martin F-35C fires an AIM-9X air-to-air missile while inverted. Lockheed Martin is looking at using technology, materials, and additive manufacturing methods to produce a "Super F-35" offering capabilities comparable to sixth-generation combat aircraft, but at lower costs. (Photo courtesy of Lockheed Martin.)

producer Northrop Grumman, long the traditional developer of U.S. naval aircraft, is ideally positioned for the coming head-to-head competition with Boeing for the U.S. Navy's F/A-XX

Lockheed Martin is also integrating digital sustainment and advanced composites across its portfolio. At the time of this writing, an updated, "Ferrari" version of its F-35 fighter was under consideration. A Lockheed spokesperson stated for this article, "We are investing to bring advanced capabilities from our 6th Gen work to enhance the relevance and capability of the F-35."

Previously, Lockheed Chief Executive Officer Jim Taiclet, speaking to investors in September, in reference to an updated Gen "5 ½" F-35, noted, "There's a very active engagement at an extremely high level with the [U.S.] Department of Defense, and I expect it'll be taken to the White House sometime soon, hopefully, to consider this kind of concept."

In addition to core aircraft manufacturers, partners such as engine and electronic systems manufacturers are also integrating these development, material, and production innovations. Both General Electric and Pratt & Whitney have been working on adaptive cycle engines and digital propulsion twins. And BAE Systems and Rockwell Collins are leading in modular avionics, electronic warfare, and mission system integration, at least in part resulting from their experience with the B-21 Project.

PROCEEDING WITH HASTE AND CAUTION

The Pentagon sees this relatively new way of doing things as a path to breaking the cycle of new weapons systems cost overruns and delays. While it may indeed achieve reforms for rapid, streamlined acquisition programs, there are significant challenges and risks ahead.

Cybersecurity is ever a threat when factories are Cloud connected. Workforce retraining is essential, as technicians move to a digitized workflow. And supply chain fragility can present bottlenecks for advanced composites and microelectronics.

Still, the direction is clear. The future of aerospace manufacturing is built differently, it is digital, automated, and software-defined. The B-21 Raider and now the NGAD F-47 represent a promising manufacturing doctrine—one that prioritizes speed, modularity, automation, and continuous upgradeability.

As the U.S. Air Force prepares for a combat environment defined by autonomous systems, contested airspace, and rapid technological turnover, the lessons of these programs will shape everything that comes next. The era of "faster, cheaper, better" has finally arrived—not as a slogan, but as an engineering reality.

A U.S. Air Force C-130J Super Hercules assigned to the 36th Airlift Squadron flies over Yokota Air Base, Japan, during a training mission, April 8, 2025. The 36th Airlift Squadron maintains mission-ready C-130J aircrew to conduct a wide variety of mission sets, including theater airlift, special operations and humanitarian aid. (U.S. Air Force photo by Yasuo Osakabe.)

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Company Highlights

The companies listed on the following pages are suppliers of parts, components, systems and repairs for the transport aircraft aftermarket. Firms indicated in **BOLD** type with their logo and description have been vetted by the publishers as bona-fide sources of supply and are the best in the business, providing quality equipment and services at a price that reflects true value for the purchaser. We suggest you contact these businesses for all your supply and repair needs, since they are dedicated to your satisfaction as customers. If they do not have the exact part or repair you require, they can act on your behalf to locate a solution for you. For more information please contact Richard Greenwald at r.greenwald@abdonline.com

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AAMSI (Associated Aircraft Mfg. & Sales, Inc.) 954-658-7267
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AAR Aircraft Component Services N.Y. 516-639-5158
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American Valley Aviation 530-283-0711
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Two F/A-18 Super Hornets launch from the flight deck of Nimitz-class aircraft carrier USS Abraham Lincoln (CVN 72) in support of Operation Epic Fury, March 3, 2026. (U.S. Navy photo.)

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MARVIN TEST SOLUTIONS

Today's armament maintainers are tasked with performing flightline (O-Level) maintenance with an assortment of legacy test sets that greatly limit the ability to quickly and efficiently verify armament system readiness, diagnose failures, and ultimately return the aircraft to full mission capable (FMC) status. Legacy test sets are typically utilized on only a single aircraft, or perform a single function supporting multiple aircraft, resulting in increased training and logistics challenges, and longer than necessary test and repair times. This not only impacts armament maintainer effectiveness, but limits the realization of Agile Combat Employment (ACE) and the development of Mission-Ready Airmen.

The need for a universal armament test solution, one that is easy to use, portable and rugged, with rapid test and setup times, and common across all platforms and weapons, has become readily apparent and increasingly in demand on the flightline. Working closely with armament maintainers from across the globe, both DOD and ally, Marvin Test Solutions (MTS) identified key functionality and capabilities essential to supporting legacy, current, and future generation platforms and weapons systems. The outcome of this effort resulted in the widely deployed and combat proven **MTS-3060A SmartCan™** Universal Armament Test Set. It has become the universal solution for eliminating the burden of multiple, aircraft-specific test sets on the flightline—delivering a standard.

A typical SmartCan kit, with all associated cables and adaptors contained in a single carry case, can replace the flightline test capabilities of over a dozen test sets across USAF fighters and UASs. It can also support a broader implementation to include bombers and surface-to-air defensive systems as needed. See Table 1 for additional details.

Table 1. O-Level Test Set Replacement Matrix

Platform	Legacy Armament Test Set(s)	Next Gen Armament Test Set
F-15C / E / EX	-198, -199	 MTS-3060A SmartCan™
F-16	5060, SST, FIST (ALE-50)	
F-22	COLT, SWAT	
A10	MSLTS, Stray Voltage Test Set, PATS 70A	
F-35	WRAP, Stray Voltage Test Set	
B-2	COLT	
B-52	Mustang	
MQ-9	AMW-103	
All	A/C Countermeasure Dispenser Test Set	
Note: MTS-3060A SmartCan currently deployed as a replacement for these test sets		

All fielded aircraft, manned and unmanned, rotary and fixed wing, can be loaded onto a single SmartCan, eliminating the traditional deployment model of using multiple aircraft-specific armament test sets on the flightline. Test results and measurement variances for each weapon are displayed in real-time for review, analysis, and fault-isolation. Additionally, test log files can easily be moved or copied for printing and analysis, supporting emerging predictive maintenance initiatives.

Unlike legacy handheld test sets that are only capable of performing stray voltage and continuity tests, the SmartCan implements functional/active MIL-STD-1760 testing to ensure armament systems are ready to support Smart weapons, before they are loaded. Coupled with munitions communication channels supporting all existing weapons protocols, it provides a full system test for all legacy and Smart weapons. It performs both pre-load and functional checkouts, the testing of multiple squib signals, and implements a cross-fire test process superior to all other O-Level armament test sets in service today.

In addition, SmartCan supports a four-year calibration cycle dramatically reducing sustainment burdens. This feature, combined with flexible software updates and multi-weapon capabilities, ensures continued relevance for future-generation platforms and munitions.

The rugged design, ergonomic layout, and small footprint enables field operation anywhere in the world, making it the ultimate tool for flightline armament test. It is designed and qualified to operate under extreme environmental conditions, meeting MIL-PRF-28800F Class 1, MIL-STD-810C and MIL-STD-461F requirements. Battery operation further enhances field usability; any AA batteries and an innovative power management system enable over 40 hours of test time without the need to replace the batteries.

Test setup and execution times are also significantly improved, and the results are striking! F-16 setup times are reduced an impressive 91%. Similarly, test execution times for a pylon utilizing MIL-STD-1760 and a LAU-129, tested for both AIM-120 and AIM-9X, saw substantial reductions of 85% and 89% respectively. See Table 2 for additional details.

Table 2. F-16 Setup / Test Time Comparison

	Test Time Improvement			
	PYLON WITH MIL-STD-1760 UMBILICAL	LAU-129 WITH AIM-120 AND AIM-9	SETUP	WEIGHT (LBS.)
EFFICIENCY IMPROVEMENT W/ MTS-3060A SMARTCAN	85%	89%	91%	95%

Advanced cybersecurity features and protections further differentiate the SmartCan, making this the most cyber-secure O-Level armament test set. Data encryption, a custom operating system, NIST Certified software for Test Program Set (TPS) development, and a removable secure data (SD) card all contribute to the enhanced cybersecurity of this test set. Its design ensures no sensitive data remains on the unit when the card is removed, meeting stringent DOD information assurance standards.

The ability to streamline TPS development and release cycles is another unique advantage of the SmartCan. ATEasy™ and SmartCanEasy create a powerful integrated TPS development environment.

Deployed on 14 platforms, in 21 countries, the SmartCan has also been endorsed by Lockheed Martin and the USAF F-16 System Program Office with SERD #75A77 and granted cybersecurity authority to operate (ATO). Additionally, it was successfully evaluated during AFWERX's Agile Combat Employment CASE initiative. Its performance continues to demonstrate unmatched versatility, cyber resilience, and operational efficiency across allied forces worldwide

SmartCan is the most advanced O-Level armament test set available, capable of testing all Alternate Mission Equipment (AME) and Aircraft Armament Equipment (AAE) including pylons, launchers, bomb racks, guns, and pods. It delivers: the quickest setup and execution times with reduced training needs, a small logistics footprint, enhanced cybersecurity, and superior active armament test capabilities—all designed to maximize warfighter readiness and combat effectiveness.

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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QinetiQ North America 781-684 4000
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24, Usacheva str., Moscow, 119048, Russian Federation

RSL Electronics USA, Inc. 845-462-6963
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S&K Logistics Services 478-971-6780
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Chaussée de Haecht,1470 Haachtsesteenweg, Brussels 1130
Belgium

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U.S. Marines assigned to Marine Medium Tiltrotor Squadron (VMM) 163 (Reinforced), 11th Marine Expeditionary Unit and Sailors assigned to Wasp-class amphibious assault ship USS Boxer (LHD 4) conduct post flight checks on an AH-1Z Viper on the ship's flight deck, Feb. 24, 2026. Boxer, flagship of the Boxer Amphibious Ready Group, is underway with the 11th MEU in the U.S. 3rd Fleet area of operations conducting integrated training that enhances warfighting capability and tactical proficiency. (U.S. Navy photo by Mass Communication Specialist 2nd Class Normand Basque.)

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The companies listed on the following pages are suppliers of parts, components, systems and repairs for the rotor-wing aircraft aftermarket. Firms indicated in **BOLD** type with their logo and description have been vetted by the publishers as bona-fide sources of supply and are the best in the business, providing quality equipment and services at a price that reflects true value for the purchaser. We suggest you contact these businesses for all your supply and repair needs, since they are dedicated to your satisfaction as customers. If they do not have the exact part or repair you require, they can act on your behalf to locate a solution for you. For more information please contact Richard Greenwald at r.greenwald@abdonline.com

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Action Aircraft 214-351-1284
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Adams Rite Aerospace 714-278-6500
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AEK Technology, Inc. 818-686-1445
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Aero Component Engineering Co. 818-841-9258
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Aero Controlex 216-291-6025
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Aero Engineering & Mfg. 661-295-0875
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Aero Engineering Support Group, Inc. 407-401-9853
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Aerospace Fasteners, Inc. 903-723-0693
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Aircraft On Ground, Inc. 214-350-5334
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AllClear Aerospace & Defense 954-538-2000
15501 S.W. 29th St., Suite 101, Miramar, FL 33027 U.S.A.

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1937 B Friendship Dr., El Cajon, CA 92020 U.S.A.

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A Bell Boeing MV-22B Osprey marks the first flight of a U.S. Navy aircraft flying with a safety-critical 3D part, during a demonstration at Patuxent River Naval Air Station, Maryland. (Image courtesy of the U.S. Navy.)

LANDMARKS: NOTABLE FIRSTS IN 3D PRINTING IN DEFENSE AVIATION

By Patrick J. Walsh

July 29, 2016: The U.S. Navy makes its first test flight of a 3D-printed component considered essential to safe flight operations. The component, a titanium link and fitting assembly for the engine nacelle of a Bell Boeing MV-22B Osprey, was printed at the Naval Air Warfare Center Aircraft Division in Lakehurst, New Jersey. The successful test marks a milestone in the Navy's plans for expanded use of additive manufacturing for the production of critical components.

January, 2019: Additive manufacturing is used to produce a titanium replacement part installed in a Lockheed Martin F-22 Raptor for the first time. The 3D-printed part is mounted in the cockpit of an F-22 by maintainers at the 574th Aircraft Maintenance Squadron at Hill Air Force Base, Utah, replacing a conventionally machined aluminum component.

August 12, 2019: Using an industrial-sized 3D printer, personnel at the U.S. Air Force 60th Maintenance Squadron at Travis Air Force Base, California, print two large, plastic replacement parts for use on a Lockheed C-5M transport in a 73-hour period. By contrast, previous procurement of the same parts through the standard production and supply chain could take as much as a year from placement of the order to delivery of the parts.

June 21, 2023: Marking the first in-flight use of a 3D printer aboard a Bell Boeing MV-22 Osprey, personnel from U.S. Marine Corps Medium Tiltrotor Squadron 164 demonstrate the utility of on-demand additive manufacturing in the field. The test, which involves the 3D printing of a medical arm cast based on a scan of a crew member's arm, is completed while the Osprey is actively involved in a flight exercise at U.S. Marine Corps Air Ground Combat Center Twentynine Palms, California. This successful demonstration is part of a larger effort by the Consortium for Additive Manufacturing Research and Education at the Naval Postgraduate School to explore various field applications of the technology.

August 7, 2025: In the United Kingdom, the U.K. Royal Air Force uses 3D printing to produce an anti-yaw spigot for a pylon assembly in one of its Eurofighter Typhoon multirole fighters. The 3D printed part serves as a temporary fix that keeps the fighter operational while maintainers await delivery of a traditionally manufactured replacement. This marks the service's first use of a 3D-printed part in a Eurofighter Typhoon.

Sources:
Ed Adamczyk, "Air Force certifies first field unit for 3D printing of aircraft parts," *Space Daily*, August 2019, spacedaily.com.
Joanna Bailey, "The RAF has 3D printed a replacement part and fitted it to a Eurofighter Typhoon for the 1st time," *Aerospace Global News*, August 2025, aerospaceglobalnews.com.
"CAMRE Helps Marines Take 3D Printing to New Heights," Naval Postgraduate School press release, July 2023, navy.mil.
John M. McHale III, "3D-printed, safety critical parts fly on V22 Osprey," *Military Embedded Systems*, August 2016, militaryembedded.com.
"NAVAIR Marks First Flight with 3-D printed, safety-critical parts," U.S. Navy press release, July 2016, navy.mil.

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THE ALLOY THAT HELPED DEFINE THE AH-64 APACHE

By Patrick J. Walsh

A prototype of the AH-64 Apache, outfitted with its distinctive four-blade main rotor, which incorporated an innovative stainless steel alloy as part of the designers' strategy to increase this attack helicopter's survivability. (Image courtesy of the U.S. Army.)

When the U.S. Army was compiling its requirements for what would become the AH-64 Apache attack helicopter — currently produced by Boeing, and originally designed and produced by Hughes Helicopter, prior to its acquisition by McDonnell Douglas in 1984 and the subsequent Boeing-McDonnell Douglas merger in 1997—survivability was high on its list of "must-have" priorities.

The Army's first-hand experience with large-scale combat deployments of its helicopter fleet during the Vietnam War had provided ample evidence of the vulnerability of rotorcraft to small arms fire. As is often the case with the development of next-generation military aircraft, the solution settled upon for the Apache leveraged an innovative approach to mechanical design enabled by advanced materials research.

Among the many upgrades that the prototype version of the AH-64 offered in comparison to previous generations of military helicopters was its four-blade main rotor, which was central to the Army's selection of the Apache over competing designs. These four main rotor blades incorporated spars constructed from AM455 stainless steel, an alloy developed by Carpenter Technology Corporation of Philadelphia, Pennsylvania.

AM455 was developed as a strong, lightweight alloy of chromium, nickel, and copper to streamline the production process for key parts used in the aviation and aircraft sectors. The particular blend of AM455 used for the Apache's rotor blades was a custom formulation exclusive to the AH-64 at the time of the model's introduction to service.

Affixed along the 22-foot length of the blades with epoxy applied to overlapping joints, the four spars attached to each blade provided redundant structural integrity for the blades in the event of direct impact by small arms fire. If one spar was damaged, the remaining spars could hold the blade together, enabling the Apache to continue flying. This innovation significantly increased the odds that the helicopter's crew would survive an encounter with hostile forces.

Sources: Joe Berk, "The Apache Main Rotor Blade Failures," *The ExhaustNotes blog*, January 2023, exhaustnotes.us/blog.
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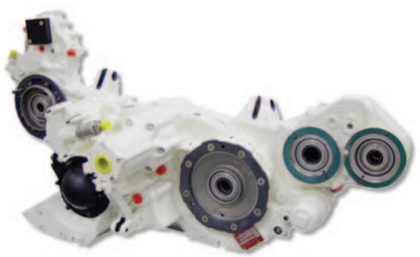

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