2024

The Program Guide

F-16 & OTHER JETS

WHAT'S INSIDE:

- The Need For Speed
- New Technology
- Money Saving Software
- New Sources of Supply
- Ukraine & Its Air Force
- Worldwide Fleets
- Company Profiles

FULL MISSION READINESS

Ours is a multi-billion-dollar industry, constantly in need of quality suppliers. Air forces around the globe know that identifying and engaging the right support partners is critical to achieving full mission readiness. In the context of one national operator, here are some suggestions for addressing this perpetual challenge.

In September 2023, the Defense Security Cooperation Agency (DSCA) announced approval for the government of Poland's purchase of up to $389 million of support for its fleet of F-16 aircraft. Requirements specified non-major defense equipment articles and services, including spares, consumables, accessories, engine repair components, and maintenance equipment, plus engineering, technical, and sustainment support.

I am sure that the Polish government will receive excellent advice from their foreign military sales (FMS) team. But I would like to share some firsthand knowledge, based on my experience working with key industry players for decades.

While it is easy to spend money, it is more difficult to spend it wisely. So here are some recommendations for some top-quality and customer service-oriented suppliers to the fighter aircraft aftermarket, applicable to the Polish fleet and those of others. We have visited the facilities of these companies and can attest that they are among the very best.

AAR, headquartered in Wood Dale, Illinois, basically created the aftermarket for aviation as we know it today. Over their 70-year history, the company has been involved in parts, manufacturing, and repairs, serving every level of the industry. Its Aircraft Component Services division, based on Long Island, New York, is consistently rated as one of the top repair shops in the country.

Frazier Aviation is a unique manufacturer of spare parts. Located in southern California since the mid-1950s, this versatile AS9100-certified manufacturer supplies machined and fabricated parts to global air forces, repair stations, and parts dealers.

HHI, in Ogden, Utah, manufacturers custom maintenance platforms to fit any defense aircraft. Serving the industry for more than 50 years, this company provides safe, cost-effective aircraft stands used the world over. If you are in Ogden for the conference, consider making time to visit their impressive facility.

Marvin Test Solutions, of Irvine, California, is a vertically integrated aerospace test and measurement company. Its products are deployed worldwide in support of most major military aircraft and munitions in use today. For instance, the MTS-3060A SmartCan Universal O-Level Armament Test Set is currently deployed on over a dozen platforms.

Sherwood Aviation, located in southeast Florida, represents an exceptional success story in our aviation defense. In a short time, Sherwood has become a go-to source for overhaul and repair of accessories, APUs, brakes, and landing gear. Most recently, this specialized service provider has expanded its offerings to include precision manufacturing of certain high-demand parts.

Simtech, in East Granby, Connecticut, epitomizes personal, top-quality service. Offering distribution and export of military spares since 1988, this company provides a wide range of parts. Woodward engine fuel-flow components and Curtiss-Wright rotary actuators are just some of their offerings.

There are of course, many other quality suppliers in our industry. Feel free to reach out, and our staff will gladly provide recommendations based on our own and industry-wide accepted experiences. We also welcome and strive to facilitate mutually beneficial communication among all those in our industry, as we work together to keep defense aircraft ready to fly.

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The Program Guide
F-16 & OTHER JETS 2024

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FRONT COVER
Image courtesy of the U.S. Air Force.

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The Program Guide - F-16 & Other Jets
A Publication of Wright Media, Inc.
P.O. Box 110382, Naples, FL 34108
P: 914-244-8899
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The Program Guide - F-16 & Other Jets, is published annually by Wright Media, Inc. Periodicals postage paid at Naples, FL and at additional mailing offices. Postmaster: Send address changes to: *The Program Guide*, P.O. Box 110382, Naples, FL 34108.

Printed outside the U.S.A.

* This magazine is an independent publication of Wright Media, Inc. As such it is not affiliated with the F-16 TCG WWR show and is therefore able to maintain an independent perspective. All information contained within has been assembled from sources believed to be reliable, but we cannot accept any responsibility for inaccuracies. The inclusion of information by or about any company or contractor does not imply endorsement by the U.S. Air Force of that organization's products or services. Regarding any inaccuracies, or if you would like to be represented in the next Program Guide for this or other events in the industry, please contact r.greenwald@abdonline.com or call 914-244-8899. Thank you.

"COVENANTS, WITHOUT THE SWORD, ARE BUT WORDS"
THOMAS HOBBS, 1651

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THE (DIMINISHING) NEED FOR SPEED

The first official flight of the YF-16 took place at Edwards Air Force Base, California, in February 1973. Phil Oestricher was the test pilot. The flight lasted 90 minutes and included wind-up turns to 3 g's at 350 knots airspeed and 30,000 feet altitude. (Image courtesy of Lockheed Martin.)

The fundamental strengths of the original F-16 design remain. At the heart of every Fighting Falcon is the lightweight fighter concept championed by John Boyd and other members of the group that came to be known as the Fighter Mafia. (Image courtesy of Lockheed Martin.)

Why Fighter Jets Fly Slower but Think Faster

By Jeff Blundell

It is 1964. "I Want to Hold Your Hand" by the Beatles is number one on the pop charts, and Walt Disney has just released "Mary Poppins." Cassius Clay beats Sonny Liston to capture the heavyweight championship of the world; just days later, the new champion changes his name to Muhammad Ali. Martin Luther King, Jr., is awarded the Nobel Peace Prize, while Nelson Mandela is sentenced to life in prison. And in Washington, the U.S. Congress passes the Gulf of Tonkin Resolution, giving President Lyndon B. Johnson authority to wage war in Vietnam.

Meanwhile, at a remote airfield, shrouded in secrecy, the Soviet Union is testing its latest prototype fighter, the Ye-155-R. After 5 years of additional testing and development, the plane is introduced into active service as the MiG 25.

In 1971, a MiG 25, referred to as "Foxbat" by NATO forces, was clocked at Mach 3.2 while flying over Israeli-held territory in Sinai. That flight confirmed what the allies already suspected: the USSR possessed the fastest military combat jet the world had ever seen.

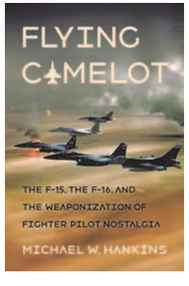
As amazing as that was, it is equally surprising that in the decades since then, no military has deployed a faster fighter. Some experimental jets have set speed records in test conditions. But when you are talking about functional, fully deployed, crewed combat jets, the MiG 25 remains the King of Speed.

So why did the Soviets build a plane with such incredible speed? And why has no one felt the need to match it? To answer those questions, we have to go back to the end of World War II and the dawn of the Jet Age.

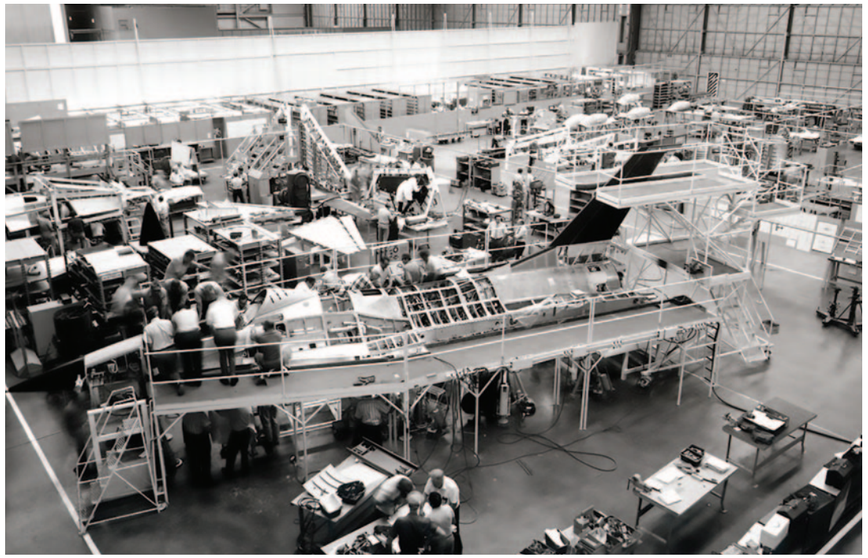
ADVANCEMENT IN TECHNOLOGY FORCED A CHANGE IN TACTICS

Dr. Michael Hankins is Curator of U.S. Air Force, Navy, and Marine Corps post–World War II Aviation at the Smithsonian National Air & Space Museum. He talked with us about how the introduction of jet power fundamentally changed the way air combat was conducted.

Dr. Michael Hankins is the curator of U.S. Air Force, Navy, and Marine Corps post-World War II Aviation at the Smithsonian National Air and Space Museum. (Image courtesy of Michael Hankins.)



Michael Hankins's book "Flying Camelot" goes deep into the personalities that shape the designs of the F-15 and F-16. (Image courtesy of Michael Hankins.)



The two YF-16 prototypes were built in Fort Worth, Texas. (Image courtesy of Lockheed Martin.)

A United States Air Force North American F-100D-60-NA Super Sabre fighter (s/n 56-2910) taking off from Nellis Air Force Base, Nevada (USA), circa 1959. (U.S. Air Force photo.)

The 30-degree seatback angle and a raised heel rest line provided increased tolerance to g forces in the YF-16. Side-mounted stick and throttle controllers allowed for more precise control under high g's. Locating combat-critical functions on these side-mounted controllers further enhanced the pilot-vehicle interface for the high-g regime, and the bubble canopy improved pilot vision for air-to-air combat. (Image courtesy of Lockheed Martin.)

North American F-100D Super Sabre at the National Museum of the United States Air Force. (U.S. Air Force photo.)

Phil Oestricher poses next to a YF-16 in Fort Worth, Texas. Oestricher would later become the first pilot to fly the YF-16 prototype. (Image courtesy of Lockheed Martin.)

John Boyd played a major role in defining the requirements that were included in the request for proposal for the Lightweight Fighter, which ultimately became the F-16. (Image courtesy of Lockheed Martin.)

YF-16 numbers 1 and 2 parked with the first two full-scale development F-16s. (Image courtesy of Lockheed Martin.)

"Things were happening a lot faster than they used to," he explains. "Airplanes were going 400, 500 miles an hour, maybe 600 during the Korean War. Because of that, the distances between the aircraft were greater. Also, the workload of the pilot was increasing, and you started needing things like the radar-assisted gun sight."

"People started thinking, 'Are guns going to be the most effective way to do combat?'," Hankins poses. "Trying to hit an enemy jet with guns only is a very difficult thing to do. What replaces that? Well, the guided missile is the solution."

According to Hankins, "It made sense to focus on agility during World War II, when you were trying to take out the Luftwaffe, and there was a lot of air-to-air combat happening. But as we moved into the Cold War era, a lot of the planners were saying, 'That might not be the thing that we're worried about.'" Thus, the combination of technical and tactical changes switched the emphasis from close range quickness and agility, which was critically important in earlier dog fighting, to top-end speed.

"There's also the bigger picture," Hankins adds, "which is that the nature of the threat as the U.S. war planners perceived it at that time has changed quite a bit." In the 1950s, U.S. Air Force leadership was focused on a potential nuclear conflict with the Soviet Union. Hankins explains how that created two distinct needs.

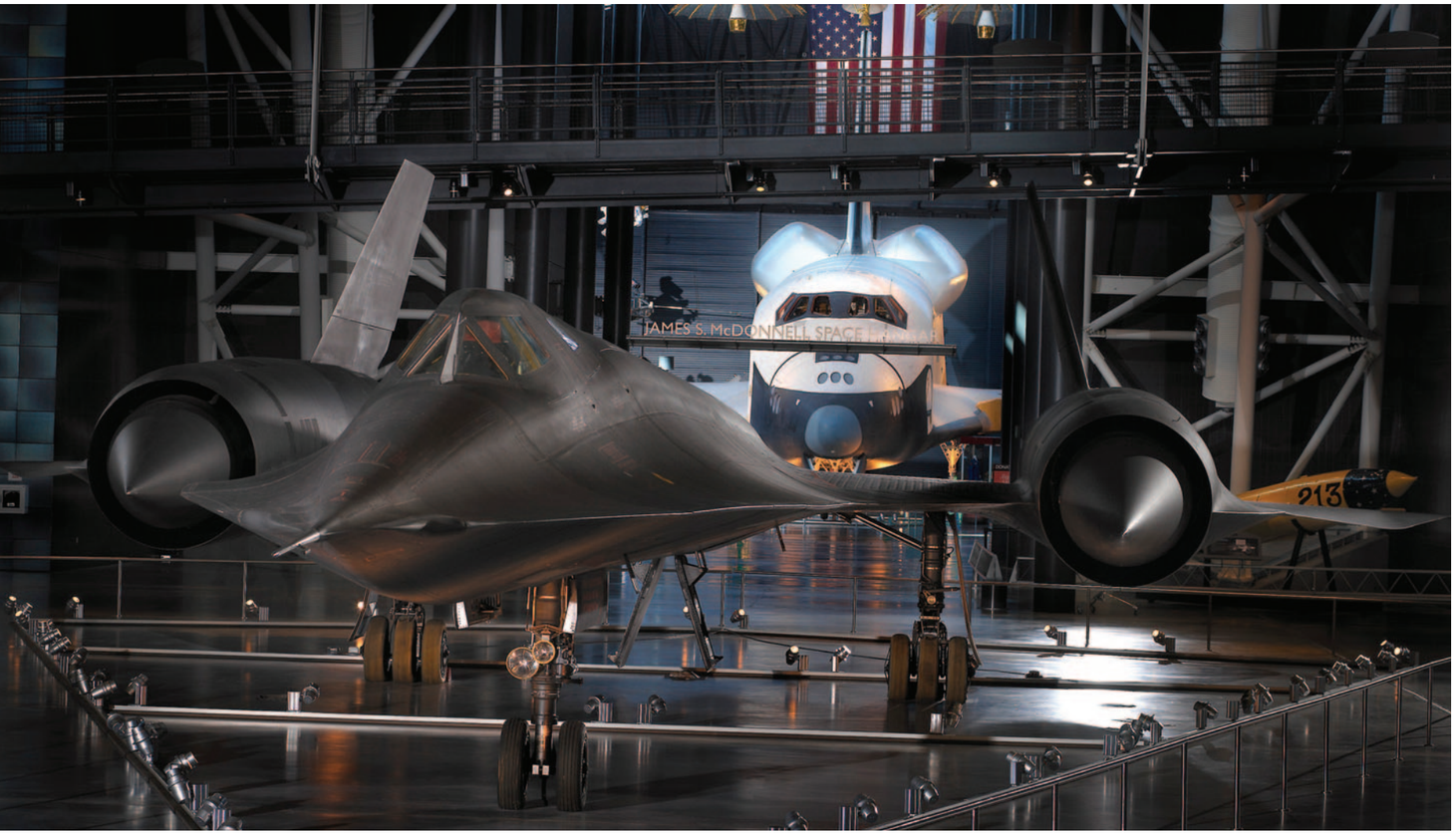
"One is if a Soviet bomber is coming at us, we want to be able to shoot it down. That means getting to it as quickly as possible, shooting it down with a missile, and then getting out of there. Second, we want to be able to deliver our own nuclear weapons. So we want an aircraft that can go as fast as possible to a target, drop a nuclear device of some kind, and then again get out of there quickly." Both of those objectives require extreme speed, paired with the ability to fly at very high altitudes. This triggered the era when "fighters" were replaced with "interceptors."

"Some people in the U.S. Air Force at that time felt abandoned," says Hankins. "Some of the fighter community felt that

Blackbirds

The SR-71 Blackbird is the fastest military plane ever deployed by the U.S. military. Officially, it could reach Mach 3.3. There are unofficial reports of pilots pushing it to Mach 3.5. (Image courtesy of National Air and Space Museum.)

An SR-71B trainer flies over the Sierra Nevada Mountains of California in 1994. (Image courtesy of the U.S. Air Force.)



A well-preserved example of the SR-71 is on display at the Smithsonian National Air and Space Museum Steven F. Udvar-Hazy Center in Chantilly, Virginia. (Image courtesy of National Air and Space Museum.)

their roles were being diminished by this emphasis on interceptors. It's not that maneuverability was completely abandoned. You have the F-104, which was clearly built for speed and interception but can also maneuver reasonably well."

In 1958, the F-104 Starfighter was the first production model to achieve Mach 2. It also was the first aircraft to reach an altitude of 100,000 feet. It had thin, stubby wings attached relatively far back on the fuselage. That design provided excellent performance at supersonic speeds but only limited turning capabilities at lower speeds and altitudes.

THE HEIGHT OF SPEED

The year 1964 was unquestionably the high point for speed enthusiasts. U.S. Air Force strategists sought something stealthy to replace the U2. They wanted a reconnaissance plane that was invisible to the enemy, but the technology to do that was still in its infancy. They decided that if you cannot hide, you need to be able to run.

As a result, just eight months after the Soviets first flew what would become the MiG 25, the U.S. Air Force conducted the maiden flight of the fastest plane it would ever deploy: the SR-71 Blackbird. Like the U2, the Blackbird was not a fighter. Instead, it strategically covered long ranges, at high altitudes, providing eyes in the sky.

"None of the Blackbirds have ever been lost to enemy fire. At least a thousand SAMs have been fired at them over the years, and none of them were ever able to hit one, because they're so fast. Officially, these things fly at Mach 3.3, but I've read accounts of pilots pushing it up to Mach 3.5," says Hankins, who has one of the few remaining Blackbirds on display at the Steven F. Udvar-Hazy Center in Virginia.

Given that spotless track record, there certainly were people in the U.S. defense forces who thought the next step was to develop a Mach 3 fighter. But a different opinion won out.

"As the MiG 25 was coming out, the U.S. Air Force and U.S. Navy were working on their next-generation plane: what was going to become the F-14 and the F-15," explains Hankins. "There was a lot of disagreement between different factions inside those organizations about what those airplanes needed to be and needed to do."

That led to a lot of "requirements creep." Greater speed meant bigger engines, and increasing the payload and range also added weight. The result was that the new model taking shape on the drawing board kept getting bigger and heavier.

"The U.S. Air Force was not really happy with how the plane was looking," explains Hankins. "They brought in a guy named John

The VENOM-AFT program is designed to accelerate the testing of autonomous operation software on existing aircraft. (Image courtesy of the U.S. Air Force.)

Major John Waters is a combat seasoned fighter pilot with over 960 combat hours in the MC-12W Liberty and F-16 Fighting Falcon. (Image courtesy of John Waters.)

Boyd. He was a former F-86 pilot with a little bit of Korean War experience and the leader of a faction that started calling themselves the Fighter Mafia."

Boyd's group pushed for a very small, lightweight, daytime-only, air-to-air fighter. They sought to shrink the airplane as much as possible and emphasize maneuverability. Not fans of large, heavy radar systems, they also did not like the idea of toting missiles. Most notably, they did not really care much about top-end speed.

"They performed an analysis of air-to-air combat and found that most air-to-air combat happens right around Mach 1, maybe a little bit under or a little bit over the speed of sound." Hankins concludes, "So, you don't really need to go faster."

"Boyd was not saying that speed was meaningless. It lets you get to the fight when you want to get there, or if conditions are not ideal for a fight, it lets you leave. So, speed is very useful for obtaining and maintaining the initiative. But once a dog fight starts, you're not going to be going that fast."

Boyd and his colleagues also pointed out that for faster speeds, more titanium is needed in the airplane design due to the heat generated. Lowering the top speed meant that they could lower the structural requirements and create something smaller, lighter, and cheaper. As a result, the U.S. Air Force could build more of them.

More than 60 years after its first flight, the Soviet-built MiG 25 is still the fastest fighter plane ever deployed. (Image courtesy of Leonid Faerberg.)

The story of John Boyd and the Fighter Mafia is told in great detail in Hankins's book, *Flying Camelot: The F-15, the F-16, and the Weaponization of Fighter Pilot Nostalgia* (Cornell University Press, 2021). But this tale did not have a storybook ending.

"Boyd had a strong influence on the F-15, but he was only one guy of many on the program. He did succeed in pushing back against some of the requirements creep. But the F-15 ended up being a compromise between a very large, very sophisticated and technologically advanced airplane that can go fast, with a very large radar in it, and a plane with the maneuverability needed for air-to-air combat," explains Hankins.

"In response, Boyd and the Fighter Mafia secretly start designing their dream version of a lightweight fighter. That eventually results in the F-16." Lockheed was the manufacturer that took Boyd's vision and made it real. And 50 years later, the F-16 is still in production.

DREAM MACHINES AND MAKING THEM SMARTER

"The fundamental strengths of the original F-16 design remain," says Jennifer Edwards, a spokesperson for Lockheed Martin. "At the heart of every Fighting Falcon is the lightweight fighter concept championed by Colonel John Boyd and the Fighter Mafia. This group favored simple and small fighter designs that could change direction and speed faster than their potential adversaries—designs that were harder to detect and yet inexpensive to produce, operate, and maintain."

The emphasis on quickness over speed helped the F-16 become the dominant fighter of its time. Yet today, priorities are changing again. Edwards states that Lockheed Martin's primary goals are not increasing speed or mobility, instead its top talent is tackling the challenge of making planes that are smarter.

"The F-16 platform continues to be a pathfinder," she says. "The X-62A VISTA is a one-of-a-kind, modified F-16 training aircraft developed by Skunk Works, in collaboration with Calspan, for the U.S. Air Force Test Pilot School. It is making groundbreaking achievements in the world of AI (artificial intelligence)."

"Additionally, the U.S. Air Force recently announced that six F-16s will be modified to test autonomous technologies under a program called Viper Experimentation and Next-gen Operations Model–Autonomy Flying Testbed or 'VENOM-AFT,'" Edwards adds. This program will test and refine approaches for adding autonomous functions to current platforms.

Top Left: First flown in 1974, the F-16 is still in service around the world today. (Image courtesy of Lockheed Martin.)

Top Right: The delivery of the first two F-16 Block 70 jets to Slovakia in January 2024 signifies a crucial starting point in bolstering the country's defense capabilities. Lockheed Martin plans to deliver fourteen jets to Slovakia. (Image courtesy of Lockheed Martin.)

Bottom Image: While the F-35 is larger and more capable, the F-16 is faster. (Image courtesy of Lockheed Martin.)

TALKING ABOUT THE SPEED OF REAL-WORLD FIGHTERS

Lockheed Martin's change of priorities from speed to brains reflects what pilots are reporting about their experiences in the air. Major John Waters flew F-16s as a member of the 77th Fighter Squadron at Shaw Air Force Base. He confirms that the maximum air speed listed on an aircraft's specifications sheet is rarely, if ever, applicable in real world conditions.

"I've been Mach 2.05 once in an F-16," says Waters, who flew more than fifty combat missions as part of Operation Inherent Resolve. "If you asked how many Viper drivers have done that, I'm willing to bet it's a very small percentage, because there's no need to do it. Ninety percent of the time, if you're above the Mach and you're slinging AMRAAMs (Advanced Medium Range Air to Air Missiles) down the track, it's mission accomplished, right? There's no need to go Mach 2."

That's not to say that going fast is not important, but it is tactical speed that matters. "Speed is life," he says. "That's a popular aviation saying, but you have to know when and where to optimize it and what you want to do with it."

Speed can help you get in the right position, and it can give your missiles a boost. "When you are out there and you're doing air-to-air long-range stuff, you'll start maybe in the high teens, maybe in the mid-20s," explains Waters, referring to the plane's altitude. "As you start running down track, you're locking into adversary aircraft. You're going to go into afterburner, you're going to accelerate out, going to start a climb, and then you're going to shoot your missiles in the high 20s and into the 30s. The idea behind it is if you can get above the Mach and you're going 1.5, you have just given that missile extra energy. Now, it can depart the jet at 1.5 Mach, and it's not having to accelerate out on its own there. You're giving it legs."

The F-16 was designed to be a lightweight daytime fighter that was both fast and maneuverable. (Image courtesy of Lockheed Martin.)

Waters qualifies this by adding that if he is delivering a GBU 38, a guided air-to-surface weapon, to a target on the ground, he wants to be going slower, usually less than the speed of sound. "If I'm dropping on a building, or if I'm dropping on a vehicle, and I want to have pinpoint accuracy, I'd want to be right at Mach 0.95. If I give that bomb 0.95 coming off the jet, to increase the chances of it being a near vertical impact and going through the roof, etc., that's what I'm aiming for. That's what I'm thinking about."

Understanding the limited applications of top-end, straight-line speed, Waters agrees with Edwards from Lockheed Martin that planes with increased data management capabilities are really what is needed.

"Flying the F-16 is easy. I think most people would agree," he says. "Where it becomes challenging is managing the formation, managing all the sensors and all the information coming in to you, putting that on the appropriate screen, and then queuing the appropriate weapon off the appropriate sensor. It's managing all the data that increases the workload."

He says that going from an F-16 to an F-35 is like switching from an old school flip phone to a brand-new iPhone 15. Not only does it do more, but it is easier to operate. Some pilots have said that a single F-35 can do the work of four F-16s.

"Their ability to run target tactics, flow off an air picture, or handle some kind of threat is quadrupled, just because the data they're seeing is presented in a way that is user-friendly. It's not like the B scope in an F-16, where you're having to figure out, 'If the radar contact is moving this way, it actually means he's flying this way.' And then you're flying in formation and doing all these things at once." That's why the fifth-generation fighters are so effective, despite being about 300 miles per hour slower than an F-16.

"I don't need a Mach 3 fighter, but I do need something to help me manage the information, manage the weapon systems, manage the sensors, and do it in a way that presents it in a way I can process it, so I can make the best decisions upon the information that's coming into the jet," concludes Waters.

Most of this would have sounded like science fiction to a fighter pilot in 1964. Yet one thing remains unchanged. Every pilot still wants a more capable aircraft than their adversary.

It is just that these days what qualifies as "capable" has changed dramatically. When pilots ask what a plane's speed is, they are just as likely to be referring to the processor speed of the onboard computer as the maximum air speed.

Advances in Technology & the Supplier Base

By Paul McDonnold

As military and civilian defense industry personnel come together in beautiful Ogden, Utah, for the 2024 F-16 Worldwide Review trade show, consider this publication your unofficial tour guide to the show. In compiling it, we spoke with some top exhibitors about their firms' latest news.

If you are attending the show, you can use this information to plan booth visits and networking with top vendors. And if you are not attending, let this serve as your virtual trade show, where you can read about the latest happenings and aftermarket suppliers to the F-16, as well as those servicing other platforms, such as the F-4, F-5, F-22, F-35, and other models not directly addressed by this event. At the very least, the following includes some insider conversation starters to jumpstart your future discussions with fellow industry players.

500,000 BLUEPRINTS

AEROMAX INDUSTRIES

Headquarters: Fort Worth, Texas
Website: aeromax.com

After moving to Fort Worth in 2019 and being bought by the financial firm Crosslake Group in April 2023 as a platform company for further acquisitions, Aeromax continues to offer customers the benefit of its expertise in sourcing or manufacturing hard-to-find aircraft components and materials. With inventories of old parts, a library of some 500,000 blueprints, and a network of specialized manufacturers, Aeromax supports platforms such as the F-5, F-16, and C-130, among others. In March 2024, the Crosslake Group completed its acquisition of two Florida-based maintenance, repair, and overhaul (MRO) firms—Continental Aircraft Support and Magnum Aircraft Repair Services—to integrate with Aeromax.

AEROSPACE MAINTENANCE SOLUTIONS

Headquarters: Solon, Ohio
Website: aerospacellc.com

In the past year, Aerospace Maintenance Solutions (AMS) achieved AS9100D certification, and one of the ways they are applying this is in reverse engineering. With diminishing manufacturing sources and material shortages (DMSMS) affecting many defense aircraft components, reverse engineering fills a critical need. When a nonfunctioning unit can be neither repaired nor procured from the usual channels, AMS duplicates and manufactures the needed part. This is no mean feat, as fit, form, function, and dimensions must be recreated to exacting tolerances. Drawing on its library of technical documents, manuals, drawings, and guidelines, AMS thus enables both defense aircraft readiness and cost efficiency.

AEROWING, DBA SUNAERO AMERICAS

Headquarters: Nashville, Tennessee
Website: aerowing.com

In April 2024, Aerowing, which does business as Sunaero Americas, acquired Miami-based East Coast Tank Sealing, a local company dating back to the early 1950s, specializing in providing aircraft tank services. Sunaero Americas Chief Executive Officer Havan Tucker states that East Coast Tank Sealing, like Sunaero, is committed to quality and customer satisfaction. "The combination of our technology and proficiency with their unparalleled experience will allow us to continue to raise the bar for tank service. We are honored to carry on the 70-year legacy of East Coast Tank Sealing."

ABOVE AND BEYOND AWARD

ATEC

Headquarters: Stafford, Texas
Website: atec.com

In January 2023, Atec announced that its subsidiaries Vital Link and Celtech were 2022 recipients of the "Above and Beyond" award from the Employer Support of the Guard and Reserve Awards (ESGR). The ESGR state committees award this accolade to employers who go "above and beyond" the requirements of the Uniformed Services Employment and Reemployment Rights Act (USERRA), which protects civilian jobs of military personnel called to active duty. Atec's 450 employees operate across eleven locations in the United States and abroad, offering design, manufacturing, construction, procurement, maintenance, and field service to military and civilian customers in aerospace and energy.

(Image courtesy of BAE Systems.)

BAE SYSTEMS

Headquarters: London, United Kingdom
Website: baesystems.com

One of the largest defense contractors in the world, among its many offerings, BAE Systems leverages its trademarked "Intrepid Shield" approach to engineer protective spheres around aircraft in battlespaces. In May 2024, the U.S. Navy chose BAE to develop a new Dual Band Decoy (DBD) system, an airborne decoy countermeasure that draws missiles away from its aircraft while jamming enemy radar. Towed behind the aircraft with fiber-optic cabling, it can be launched manually by the pilot or automatically. BAE will develop the system at its Nashua, New Hampshire, facility, initially for the Navy's F/A-18E/F Super Hornet, but with this capability to be available for additional platforms.

BAUER

Headquarters: Bristol, Connecticut
Website: bauerct.com

This maker of aircraft component test and support equipment was established in 1916. As of June, Bauer has separated its wheel and brake equipment line into its own business unit, both to adapt to forecasted growth in the market and to enhance and expand its product offerings. "This strategic move will help position Bauer for success through innovation in order to exceed customer expectations," says Bauer Chief Operating Officer and Bauer Wheel and Brake General Manager Mark Auletta. This is part of Bauer's strategy to provide a turnkey solution for aircraft wheel and brake shops worldwide.

Collins Aerospace's ACES 5 Ejection Seat in action. (Image courtesy of Collins Aerospace.)

COLLINS AEROSPACE

Headquarters:
Charlotte, North Caroline
Website: collinsaerospace.com

A subsidiary of RTX Corporation (formerly Raytheon Technologies), Collins Aerospace announced earlier this year that it signed an agreement with Fokker Services Americas to provide American operators of Collins's Integrated Drive Generators (IDG), which convert aircraft engine power to electric power, with a high-quality, dependable, and domestic repair option. As part of the agreement, Fokker's LeGrange, Georgia, MRO center will implement IDG repair capabilities and increase its inventory of Collins's related components. The agreement "will expand Collins's IDG MRO services to Fokker customers in the United States, providing them with reliable parts and services to help keep their planes in the air," according to Ryan Hudson, Vice President of Power and Controls Aftermarket for Collins.

Defense Technology Equipment President, Franck Benzaria. (Image courtesy of DTE)

DEFENSE TECHNOLOGY EQUIPMENT

Headquarters: Sterling, Virginia
Website: defense-tech.com

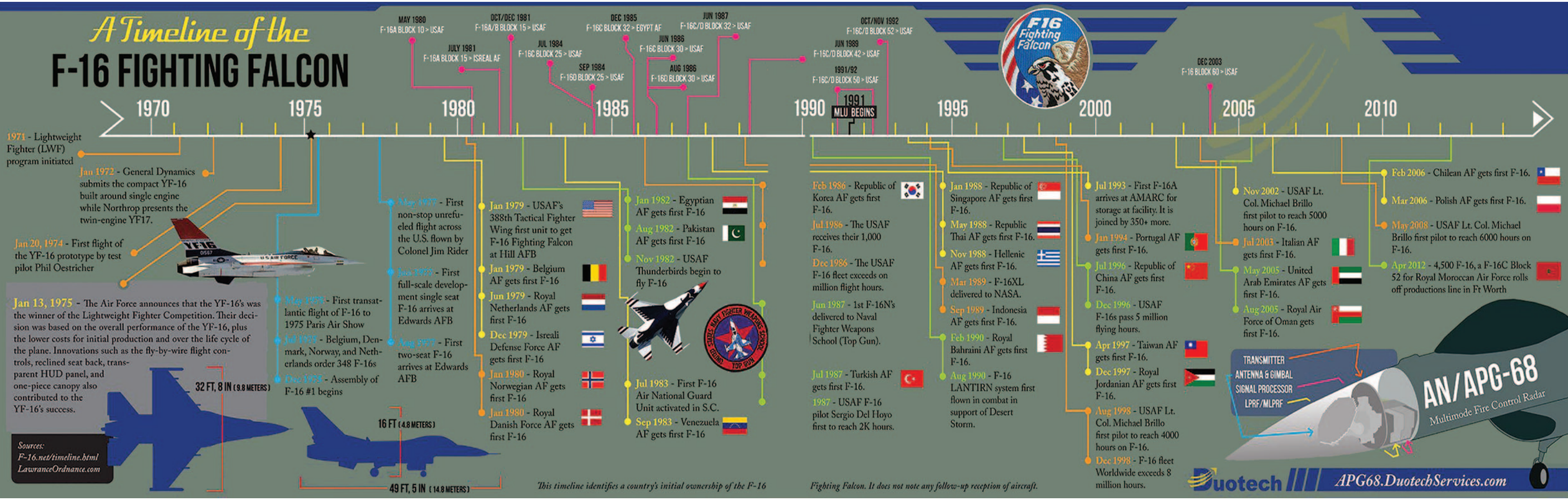
Defense Technology Equipment (DTE) is a logistics and supply chain company offering armed forces and other customers "nose-to-tail" aircraft components, covering the spectrum from accessories to landing gear to complete aircraft engines. This year, DTE celebrates 35 years in business, during which time the company has expanded from 2,500 square feet of facility space to 64,000 square feet. Senior Vice President Maria Badillo, says that while the pandemic was challenging, DTE is very busy now and looking toward future expansion. "With the current situation in Ukraine, for example, we haven't even tapped into that market," she says. "But we are seeking to develop Eastern Europe, as more countries get to operate and use the F-16."

When company president Franck Benzaria first started DTE in 1989, he did so in a two-by-two closet equipped with a fax machine. In addition to facility size, he has seen the company grow in support capabilities. "We not only support the legacy blocks of the F-16," Benzaria says, "but also the newest blocks." Apart from Maria and Franck, the DTE team includes both career civilians and ex-military personnel with a passion for aviation and helping customers worldwide find solutions that others miss.

DIT-MCO INTERNATIONAL

Headquarters: Kansas City, Missouri
Website: ditmco.com

Corporate evolution can be an interesting thing. DIT-MCO began operating in 1948 under the name Drive-In Theatre Manufacturing Company, producing speakers for drive-in movies, soon expanding into movie screens and concession stand lights. Then in 1954, they manufactured the very first automated wiring analyzer, and that changed everything. The drive-in business was spun off to employees. And in the years since, DIT-MCO's wiring analyzers have played a critical role in aviation defense and aerospace projects, including the Apollo space program and Webb telescope, as well as in maritime and other fields.



An infographic exploring the F-16's history. (Image courtesy of Lee Cloer, Duotech Services)

DUOTECH SERVICES

Headquarters:
Franklin, North Carolina
Website:
duotechservices.com

Founded in 1982, Duotech originally focused on repairing and supporting instrumentation tape recorders for the U.S. Department of Defense. Husband and wife founders Dan and Cheryl Rogers have seen the industry change, with analog recording technology mostly disappearing. "From those very early days of just Dan and I running it all, I could not visualize then that we would be the size we are today," says Cheryl. Currently, their services include repairing obsolete equipment and upgrading aircraft radar systems. Duotech's ARGUS Radar Warning Receiver, an affordable digital threat detection system designed for platforms including the F-5, F-16, C-130, and others, has been helping to protect international fleets since 2022.

ELBIT SYSTEMS OF AMERICA

Headquarters:
Fort Worth, Texas
Website: elbitamerica.com

The F-35 Helmet Mounted Display System is the product of a joint venture between Collins Aerospace and Elbit Systems of America. (Image courtesy of Collins Aerospace.)

It has been a busy year so far for Elbit Systems of America. In January, Luke Savoie became President and Chief Executive Officer, taking over from Raanan Horowitz, who had led the firm for most of two decades. In March, Ethisphere named the company one of the world's most ethical companies. And in May, Elbit marked the 3,000th delivery of the F-35 Helmet Mounted Display System (HMDS), which it produces through a joint venture with Collins Aerospace. Guests such as U.S. Representative Chris Pappas joined Elbit employees to celebrate this milestone at Elbit America's location in Merrimack, New Hampshire. Elbit's Senior Director for Electronic Systems Bob Hess calls the F-35 HMDS "the most advanced helmet-mounted display system in the world." And it represents just one example of the agile solution that Elbit produces to help warfighters "dominate the battlefield, wherever the fight takes them."

FATIGUE TECHNOLOGY

Headquarters:
Tukwila, Washington
Website: fatiguetech.com

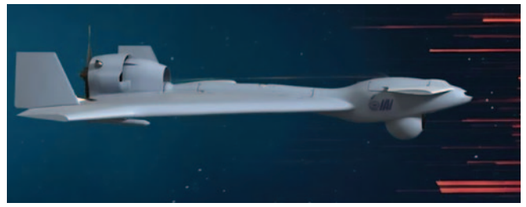
Another company with a strong history dating back to the 1960s, Fatigue Technology helped pioneer cold expansion processes to fight metal fatigue in aircraft wings and other parts. Today, it continues at the forefront of innovation, offering solutions for both new and aging aircraft, from bushings that leverage the science of cold expansion for easier installation and improved corrosion resistance, to rivetless nut plates that eliminate rivet holes while enhancing fatigue life of the structure. Recently, the company announced that Wencor Group would become its preferred stocking distributor for the FTI-8101 Split Sleeve Cold Expansion tooling line. Fatigue Technology also received a fifth straight Platinum Source Preferred Award (13th overall) from Northrop Grumman.

A CH-146 Griffon of the 438 Tactical Helicopter Squadron, Royal Canadian Air Force. (Image courtesy of Wikimedia Commons.)

GASTOPS

Headquarters:
Ottawa, Ontario, Canada
Website: gastops.com

Since 1979, Gastops has specialized in critical component condition intelligence, enabling predictive maintenance. Understanding component wear is a key to optimizing availability, reducing inefficiency, and lowering costs, and Gastops serves manufacturers and operators of gas turbines, gearboxes, and other rotating equipment in critical applications, including aviation and industrial power. In 2023, the company announced that Bell Textron Canada had selected Gastops's ChipCHECK debris analysis tool to support the Royal Canadian Air Force's CH-146 Griffon helicopter fleet.



(Image courtesy IAI CATALYST.)

IAI NORTH AMERICA

Headquarters:
Herndon, Virginia
Website: iainorthamerica.com

A subsidiary of Israel's largest aerospace and defense company, IAI North America launched its first innovation center in the United States in January. The center's first program, IAI CATALYST, is a business accelerator designed to build cooperative relationships between IAI and startup companies in sectors such as aerospace, quantum science, sustainability and energy technology, and trusted AI operations. Through technical and business support, mentorship, and financial incentives, this program will assist new firms entering the market and help spur rapid growth. "It demonstrates IAI's commitment to promoting cutting-edge technological innovation and opportunities by investing in local U.S. startups. The work we will do there will help create the next generation of leading technology through collaboration with IAI from the very beginning," says Stephen Elliott, President and CEO of IAI North America.

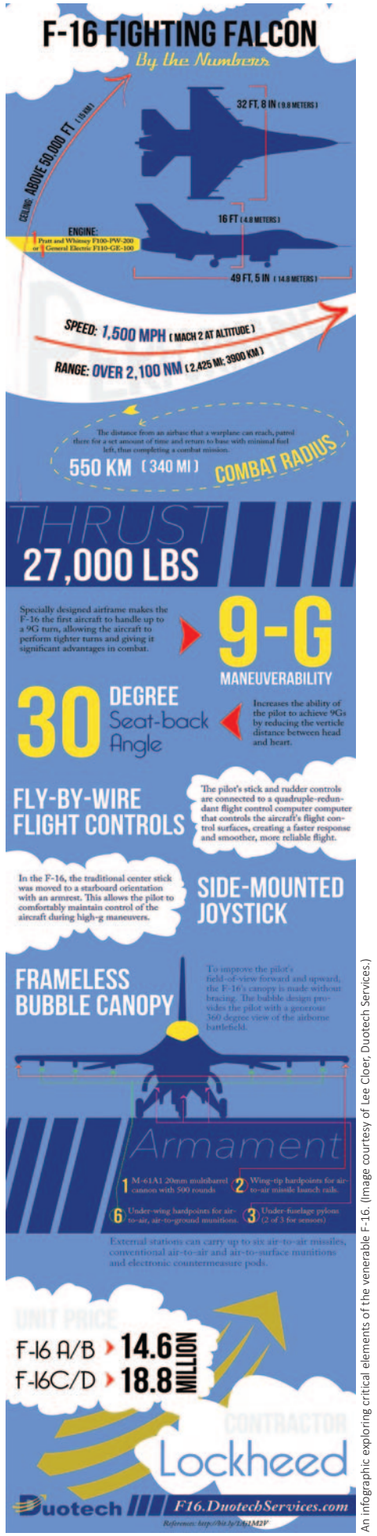
IAI CATALYST
Boosting The Future of Innovation

IBC MATERIALS AND TECHNOLOGIES

Headquarters: Lebanon, Indiana
Website: ibcmaterials.com

IBC Materials and Technologies, a member of the IBC group of companies, was founded in 2002. Their specialty is creating advanced surfaces that improve and extend the lives of critical components used on the F-16 and other platforms. IBC founder and President Dr. Solomon Berman says the company is coating parts, such as missile launcher components, with low-friction, nano-composite coatings "that provide significant improvement in life, corrosion resistance, and wear resistance, and extend the performance of the launcher."

IBC also has developed an environmentally friendly paint stripping system called Ultrasonically Activated De-Painting (UADP), which uses ultrasonic waves to separate paint and primer from metal parts, without the need for harsh chemicals or blasting. In June 2023, the U.S. Air Force awarded IBC an "Award for Outstanding Technological Achievement in the Field of Maintenance and Sustainment" for the UADP system.



An infographic exploring critical elements of the venerable F-16. (Image courtesy of Lee Cloer, Duotech Services.)

L3 HARRIS

Headquarters:
Melbourne, Florida
Website: l3harris.com

In April, this global technology company and defense contractor with expertise in surveillance, electronic warfare, and microwave weapons, announced that its avionics products repair station located in Grand Rapids, Michigan, was awarded an EMAR-145 (European Military Airworthiness Requirement Part 145) certification, making it the first U.S. repair station to receive this certification. This marks a milestone completed eight months ahead of schedule, after Airbus Helicopters approached the company about pursuing the certification in early 2023 to support delivery of H160Ms to the French government. In November 2023, having delivered electronic warfare (EW) systems to the U.S. Navy for decades, L3Harris announced that the Navy had awarded it a contract to develop a "next generation" EW system for the F/A-18 that focuses on detecting and protecting pilots against emerging and future threats to their safety

A UH-60 Black Hawk lifts off. (Image courtesy of Wikimedia Commons, photo by Staff Sgt. Joseph Wilbanks.)

MARTIN BAKER AMERICA

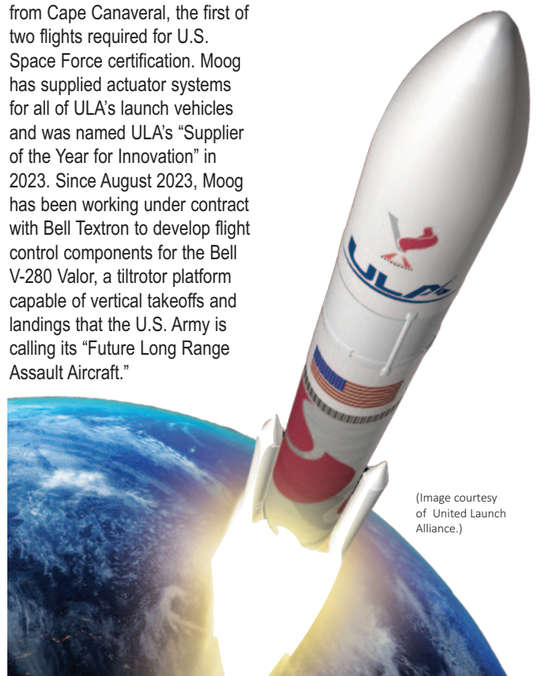
Headquarters:
Johnstown, Pennsylvania
Website: martin-baker.com

Martin Baker America is the U.S. subsidiary of the world's largest manufacturer of ejection seats, with over 70,000 sold to ninety-three air forces worldwide. In 2023, the company extended an agreement with Lockheed Martin subsidiary Sikorsky to supply seating for Blackhawk helicopters used by the U.S. Army, as well as by international customers for troop transport, search and rescue, medical evacuation, firefighting, and other missions. According to the company the seats' "patented energy attenuation system" offers "unparalleled levels of safety" to aircraft operators, gunners, and troops.

MOOG

Headquarters: Elma, New York
Website: moog.com

Since being granted its first U.S. patent for an electrohydraulic servo valve (the "Moog Valve") in 1953, this company, named after its founder William Moog, has designed and created electric, electro-hydraulic, and hydraulic motion controls and systems for customers in aerospace and defense, as well as other industries. In January, the company's new hydraulic actuators successfully steered the United Launch Alliance's (ULA) Vulcan rocket's launch from Cape Canaveral, the first of two flights required for U.S. Space Force certification. Moog has supplied actuator systems for all of ULA's launch vehicles and was named ULA's "Supplier of the Year for Innovation" in 2023. Since August 2023, Moog has been working under contract with Bell Textron to develop flight control components for the Bell V-280 Valor, a tiltrotor platform capable of vertical takeoffs and landings that the U.S. Army is calling its "Future Long Range Assault Aircraft."



(Image courtesy of United Launch Alliance.)

$800M

OSHKOSH AEROTECH

Headquarters:
Oshkosh, Wisconsin
Website:
oshkoshaerotech.com

Sometimes the success of an air mission hinges on what happens on the ground. In August 2023, Oshkosh Corporation, a specialist in ground handling vehicles, bought JBT Corporation's Aerotech business for $800 million. Aerotech's Defense Aviation Ground Equipment includes critical equipment for repositioning, deicing, and maintaining aircraft, as well as moving and loading cargo. Changes at the company continued in January of this year, when Aerotech's president Dave Burdakin retired and was replaced by 38-year industry veteran Chuck Durst. Burdakin will stay on in a part-time advisory role as parent company Oshkosh seeks to expand its presence in the air transportation support space.

PARKER AEROSPACE

Headquarters:
Mayfield Heights, Ohio
Website:
www.parker.com/us/en/industries/aerospace.html

The aerospace division of Parker Hannifin Corporation, Parker Aerospace announced in April 2024 that it will take part in the "HyFIVE" industry/academic consortium, along with Marshall Aerospace, GKN Aerospace, the University of Manchester, the University of Bath, and Cardiff University. These organizations will be working together to develop a liquid hydrogen fuel system and supply chain, with the goal of enabling zero-emissions aviation by the 2030s. By cultivating technology in the areas of storage, conveyance, indication, fueling, and venting, the consortium plans to create a hydrogen fuel architecture capable of supporting multiple types of aircraft, for both defense and civilian use, with hydrogen electric propulsion or hydrogen combustion powertrains.

VIAVI SOLUTIONS

Headquarters: Chandler, Arizona
Website: viavisolutions.com

Viavi Solutions specializes in network test, measurement, and assurance technology. Its government and defense division provides research and development, flightline, factory, and return-to-service test solutions to customers. Its product lines include fiber-optic avionics, global positioning system (GPS) signal simulators, and tactical air navigation systems, among others. In 2022, Viavi leased 15,000 square feet of new office space in Chandler, Arizona, where it recently relocated its headquarters from Silicon Valley, and where it has established a scholarship at the University of Arizona Wyant College of Optical Sciences to help grow the local tech ecosystem.

Among its many other highly effective products, the company's GORE SKYFLEX Aerospace Materials, approved for use on the F-16, encompass dry tapes and gaskets that can be easily applied without the need for extended curing time or cleanup. "F-16 aircraft maintainers value GORE SKYFLEX Aerospace tapes and gaskets, because they enable rapid install, as well as fuel sealing the first time and every time," says application engineer Nate Mooney.

Gore has been providing reliable, tested, and proven solutions for the most demanding aerospace missions since the early 1960s. (Image courtesy of W.L. Gore & Associates.)

W.L. GORE & ASSOCIATES

Headquarters:
Newark, Delaware
Website: gore.com

Founded on New Year's Day 1958 by husband-and-wife team Wilbert and Genevieve Gore in the basement of their Newark, Delaware, home, this company's first product was a cable coated with a polymer known as PTFE (polytetrafluoroethylene), discovered at DuPont in 1938. Today, W. L. Gore & Associates (Gore) is one of the 200 largest privately held companies based in the United States, with more than 13,000 employees across five continents.

Nate Mooney, Application Engineer at W.L. Gore & Associates. (Image courtesy of Jenn Haupt, W.L. Gore.)

W.L. Gore remains a major player in protected cables. Its microwave cable assemblies are designed to withstand rough installation and maintenance activities and survive extreme aerospace conditions, including dramatic temperature and pressure changes and contamination by fuel, oil, and other fluids, all while maintaining signal transmission integrity. In addition, Gore's full line of high data rate copper, fiber optic, and hybrid cables support the newest open-source architectures and protocols, including Ethernet, CAN Bus, USB, HDMI, and others. "Having served as a squadron maintenance officer and aviator, I can attest to the vital role cables play in ensuring mission success. Their durability and reliability were essential in enabling my aircrew and me to accomplish our objectives and safely return home," says Jeff "Rev" Woods, market development at Gore.

Jeff "Rev" Woods, Market Development Leader at W.L. Gore & Associates. (Image courtesy of Jenn Haupt, W.L. Gore.)

WILLIAMSRDM

Headquarters: Fort Worth, Texas
Website: williamsrdmdev.com

Based in Fort Worth, Texas, WilliamsRDM is a woman-owned small business founded in 1963. Across its history, it has developed and manufactured armament system testers, ground support equipment, and connectors for preload and I/O level testing of various fighter aircraft platforms. During that time, the company has seen many changes, including armament testing devices becoming steadily smaller and more powerful.

WilliamsRDM's WP500 Smart Weapons Tester in use. (Image courtesy of Ben Hoskins, WilliamsRDM)

Tres Moulton, Business Development Manager at WilliamsRDM. (Image courtesy of Ben Hoskins, WilliamsRDM.)

Its latest device, the WP500 Smart Weapons Tester, fits in the palm of your hand. "It saves you the trouble of getting a much bigger tester out to the flight line to diagnose the issue," says Director of Engineering Mark Walters. The WP500 combines and extends the capabilities of previously separate preload weapon testers for F-15s, F-16s, F-35s, and A-10s. Not only does this "third-generation" tester check that the bus has traffic, it also confirms that the traffic is supposed to be there.

The WP500 tests smart weapons, guiding diagnoses and repairs: if a weapon fails a test, a built-in LCD display enables drilling down into a detailed report. "It's helping you diagnose the issue," says Tres Moulton, Business Development Manager at WilliamsRDM, and it provides "a more thorough reporting capability to help you isolate the fault."

Mark Walters, Director of Engineering at WilliamsRDM. (Image courtesy of Ben Hoskins, WilliamsRDM.)

The flight of Ukrainian Air Force Lieutenant General Vasiliy Nikiforov and Commander of the 187th Fighter Wing of the Alabama National Guard Lieutenant Colonel Scott Patton (in the rear seat) during the "Safe Skies-2011" joint military exercises among Ukrainian, U.S., and Polish air forces. (Image courtesy of Airliners.net)

Ukraine and its Air Force

By Tracy Martin

Situated in Eastern Europe, Ukraine ranks as the second-largest European nation, following Russia, which shares its eastern and northeastern borders. To the north lies Belarus, while to the west stand Hungary, Poland, and Slovakia. In the southwest, Ukraine shares borders with Moldova and Romania, with a coastline along the Black Sea. The landscape of Ukraine consists primarily of plateaus and fertile steppes (plains with few trees), crossed by rivers.

On historical maps from the seventeenth century, the region was often labeled as the "Ukraine, land of the Cossacks." Between 1764 and 1781, Catherine the Great expanded the territory of the Russian Empire to encompass a significant portion of central Ukraine. Following the annexation of Crimea in 1783, these newly acquired territories, referred to as Novorossiya, were made accessible for Russian settlement. Under the governance of the tsarist autocracy, a policy of Russification was implemented, aimed at diminishing the prominence of the Ukrainian language and restricting the expression of Ukrainian national identity.

Following the Russian Revolution of 1819, renewed Ukrainian nationalism fueled the short-lived Ukrainian People's

(Photo courtesy of Defense of Ukraine.)

A Ukrainian Su-27 Flanker shows off its power in flight. (Image courtesy of Wikipedia Commons.)

UKRAINE FAST FACTS

Capital: . . . . . .Kyiv

Land area: . . . . . .233,062 square miles
. . . . . .(603,628 square kilometers)

Religion: . . . . . .87% Christian
. . . . . .11% no religion
. . . . . .2% other

Population: 37,707,400

Urban population: 22,569,220 (2022)

Official language: . . . . . .Ukrainian

Literacy rate: . . . . . .estimated at 100%

Currency: . . . . . .Hryvnia

GDP: . . . . . .$188.943 billion (rank 58th)

Year of Independence: 1990

Government: . . . . . .
. . . . . .Unitary semi-presidential republic

President: . . . . . .Volodymyr Zelenskyy

Ukrainian Armed Forces: Land, air, and sea

Military Service:
. . . . . .Draft for men 25 years of age

Active military personnel: 900,000

Reserve military personnel: 1,200,000

Republic. Bolsheviks seized power, consolidated control over significant portions of the former empire, and established the Ukrainian Soviet Socialist Republic, which became a constituent republic of the Soviet Union upon its formation in 1922. During World War II, German occupation led to the deaths of approximately 7 million Ukrainian civilians.

Following dissolution of the Soviet Union in 1991, Ukraine seized the opportunity to again declare its independence, adopting a new constitution for self-governance in 1996. In 2014, a series of large-scale protests, famously known as the Euromaidan movement, or the Maidan Uprising, sparked civil unrest and protests, which ushered in a new Ukrainian government.

In 2014, Russia annexed Crimea, a peninsula of Ukraine, utilizing Russian Navy ships stationed in Sevastopol. Following this annexation, Russia instigated a proxy war in the Donbas region of Ukraine. The conflict with Russian-backed separatists in Donbas changed rapidly over a short time and eventually expanded. In February 2022, the Russian Armed Forces launched a full-scale invasion of Ukraine, sparking intense combat actions in the region.

Throughout the conflict, the Ukrainian Armed Forces has collaborated with its auxiliary and wartime-affiliated organizations to actively defend the country. An important factor in Ukraine's response has been its acquisition of Western weapons and materiel from North Atlantic Treaty Organization (NATO)

Pilot Sylvester Sonevytskyi at the helm of the Nieuport 17 aircraft, circa 1919. (Photo from the magazine Chronicles of Red Kalina, now in public domain.)

Ukrainian president Volodymyr Zelenskyy inspects a Ukrainian air force Su-27 armed with a HARM missile. (Photo courtesy of Ukrainian Air Force.)

(Photo courtesy of Defense of Ukraine.)

Ukraine President Volodymyr Zelenskyy (front seat) and Danish Prime Minister Mette Frederiksen pose in a Danish F-16 fighter. (Image courtesy of the Ukrainian Ministry of Defense.)

member armed forces, as well as ex-Soviet stock from various Eastern European nations. Additionally, captured Russian tanks, armored vehicles, and other weaponry have contributed to the ongoing modernization and expansion of Ukraine's armed forces. This influx of resources has bolstered the country's defenses as it continues confronting the invading forces.

Culturally, Ukraine still has close ties to Russia. While Ukrainian serves as the nation's official language, Russian remains prevalent, particularly in the eastern and southern regions.

Traditionally, the nation's economy has been based on agriculture and that continues to the present. In 2021, Ukraine was one of the world's largest wheat exporters. But due to the Russian invasion, and despite emergency financial support from the International Monetary Fund (IMF), its economy shrunk by 35 percent in 2022.

UKRAINIAN ARMED FORCES

Following the collapse of the Soviet Union, Ukraine claimed a formidable military presence of about 780,000 personnel, along with the world's third-largest cache of nuclear weaponry. In 1992, Ukraine committed to the Lisbon Protocol, relinquishing all nuclear arms to Russia for dismantling, and to becoming a non-nuclear state under the Nuclear Non-Proliferation Treaty. By 1996, the country had successfully eliminated its nuclear arsenal.

Ukraine's armed forces encompass a diverse array of branches, including the Air Force, Air Assault Forces, Navy, Marine Corps, Ground Forces, Special Operations Forces, and Territorial Defense Forces. Within its Navy, there also is a Naval Aviation component. The Sea Guard operates as Ukraine's coast guard service, under the auspices of the Border Guard Service.

Ukraine actively engages in multinational military exercises, often hosting units from other countries, as part of collaborative programs such as NATO's Partnership for Peace. These exercises serve to enhance cooperation and interoperability. Additionally, Ukraine has been gradually modernizing its military equipment, transitioning from Soviet-era weaponry to NATO-standard armaments.

UKRAINIAN AIR FORCE

Ukrainian military aviation traces its origins back to the winter of 1917, with the establishment of the Ukrainian People's Republic Air Fleet. In 1918, the West Ukrainian People's Republic formed its own aviation corps, aligning with the Ukrainian Galician Army. Aircraft utilized by Ukraine included the SPAD S.VII, manufactured in Belgium, and French Nieuport 17 biplanes. During this era, the Air Fleet is documented as flying close to 200 aircraft spanning twenty-six different models.

Throughout World War II, Ukrainian aviators played integral roles in combat operations as part of the Soviet Air Force. Notably, Ivan Kozhedub stands out among these pilots, achieving distinction as the highest-scoring Allied ace with over sixty credited solo victories.

After the dissolution of the Soviet Union in 1991, Ukraine found itself in possession of numerous aircraft left on its territory. However, due to chronic under-investment following independence, the Ukrainian Air Force experienced significant challenges, resulting in much of its inventory being mothballed or otherwise rendered inoperable. Despite these difficulties, Ukraine's domestic defense industry, Ukroboronprom, and its Antonov subsidiary have been working to maintain the older aircraft and ensure they are in serviceable condition.

The Ukrainian Air Force played a role in the initial conflict in Donbas, but operations were suspended in the region following a ceasefire agreement in 2014. However, since February 2022, the Air Force has been actively engaged in combat operations in response to the Russian invasion. While the majority of its aircraft inventory still is comprised of Soviet-made models, efforts are underway to modernize and diversify the fleet. Pilots are currently undergoing training to operate aircraft such as the F-16, signaling Ukraine's commitment to enhancing its air capabilities amid the ongoing conflict.

In August 2024, the United States approved the donation of F-16 fighters to Ukraine from Denmark and the Netherlands. Following this decision, both countries declared their commitment to providing Ukraine with aircraft, with Denmark pledging nineteen and the Netherlands offering forty-two F-16s. The initial announcement of the delivery of eighteen F-16s from the Netherlands was made in December, with expectations that the rest will arrive in Ukraine well before the end of the year. According to the Danish Defense Minister, preparations are underway to ensure the delivery of the first F-16s to Ukraine, with a similar arrival time if all goes as planned.

In May 2024, Belgium announced that it will donate thirty F-16s to Ukraine. Norway also has expressed its intention to send F-16s to Ukraine, with specific details regarding the number of aircraft pending at the time of this writing.

The F-16 represents a significant leap forward from the fighters currently in use by Ukraine. Thus, its introduction will bolster Ukraine's existing air defense artillery systems, enhancing its capabilities to intercept incoming Russian cruise missiles and other less-sophisticated surface-to-air threats. As a versatile multirole fighter, the F-16 also can provide crucial air support for Ukrainian ground operations, serve as a deterrent against Russian attempts to control additional airspace, and counter Russian aircraft engaged in close air support missions near the front lines.

UKRAINE'S AIR FLEET

Symbol of the Ukrainian Air Force.

Following is a list of the total numbers of aircraft already part of or to be relatively soon added to the Ukraine's Air Force's fleets at the time of this writing

COMBAT AIRCRAFT

F-16AM/BM Fighting Falcon . . . . . .61 on order
Mikoyan MiG-29 58
Sukhoi Su-24 14
Sukhoi Su-25 20
Sukhoi Su-27 31

TRANSPORTS

Antonov An-26 3
Antonov An-26 22
Antonov An-70 1
Antonov An-178 . . . . . .3 on order
Ilyushin Il-76 4

HELICOPTERS

Mil Mi-8 15
Mil Mi-17 25

TRAINER AIRCRAFT

Aero L-39 44

UNMANNED UAVs

AeroVironment RQ-11 72
Bayraktar TB2 . . . . . .48 on order

LEGACY WORLDWIDE FIGHTERS 2024

By Tracy Martin

In safeguarding a nation's defense, the reliability of proven aircraft is paramount. Yet acquisition of advanced fifth-generation fighters like the F-35 Lightning II remains out of reach for many countries due to financial constraints or technological barriers. Consequently, a significant portion of the global community relies on fourth-generation fighters to uphold their military presence, deter potential threats, and defend their territorial integrity.

Amidst this landscape, cost-effective and battle-tested aircraft such as the Northrop F-5 Freedom Fighter, McDonnell Douglas F-4 Phantom, and General Dynamics/Lockheed Martin F-16 Fighting Falcon play a crucial role. These dependable platforms continue to fulfill the defense aviation requirements of numerous nations, ensuring security without compromising on effectiveness.

F-4 PHANTOM

Since its inception in 1960, the F-4 Phantom has played a pivotal role in military operations, notably serving as a primary fighter during the Vietnam War for the U.S. Navy and U.S. Marine Corps. Originally conceived as a carrier-based interceptor, this two-seat fighter-bomber was engineered to meet the aerial defense requirements of its time.

Despite its initial design lacking internal space for a cannon, the F-4 boasts nine external hard mounting points, allowing it to carry an arsenal of up to 18,650 pounds of armaments. This includes a variety of air-to-air and air-to-surface missiles, as well as both guided and unguided nuclear weapons. Even when fully loaded with a takeoff weight exceeding 60,000 pounds, the F-4 can achieve speeds of up to Mach 2.23, ascend at a rate surpassing 41,000 feet per minute, and operate at altitudes of up to 60,000 feet.

Modern variants such as the F-4E Peace Icarus 2000 and the F-4E Terminator 2020 ensure the F-4's continued relevance in military operations. Several countries still rely on the F-4, underscoring its versatility in meeting diverse defense needs.

The Islamic Republic of Iran Air Force originally had 225 Phantom IIs delivered by the United States, making it the second-largest export customer for the type. These aircraft were received before the Iranian Revolution in 1979 and were used extensively in the Iran-Iraq war. As many as sixty-three F-4s still actively serve Iran.

The significantly reduced inventory of the Republic of Korea Air Force still includes around twenty F-4 Phantom IIs, though these are scheduled for replacement. In May 2022, a proposal was presented during the Korea Security and Defense Forum for the nation to obtain more Lockheed Martin F-35s and Korea Aerospace Industries (KAI) FA-50 and KF-21 fighters. In 2023, the U.S. State Department approved a $5.06 billion sale of twenty-five F-35A fighters.

In April 2024, South Korea conducted a final live-fire drill with its F-4 Phantoms amid the largest U.S.-R.O.K. air exercise of the year. The Republic of Korea Air Force's F-4 Phantoms fired precision-guided AGM-142 Popeye air-to-surface missiles on a range near the Yellow Sea. These training sessions marked the nation's farewell to its remaining Phantoms before the fleet's phase-out on June 8, as well as a goodbye to its AGM-142 Popeyes, as the F-4 jets were the nation's sole aircraft capable of carrying the missiles.

The Turkish McDonnell Douglas F-4E Phantom IIs have stood the test of time, boasting an impressive operational history spanning nearly five decades. Among the last frontline third-generation fighters, these adversary aircraft now confront an array of modern threats and find themselves surpassed by more advanced fighters. However, Turkey has taken proactive measures to enhance the capabilities of its fleet, particularly its nineteen F-4E Terminators. Through extensive upgrades, these aircraft have been modernized to levels comparable to early variants of the F-15, a testament to Turkey's commitment to maintaining its formidable air force.

Despite their age, F-4E Terminators exhibit remarkable effectiveness in combat scenarios, showcasing capabilities that rival those of newer aircraft. In many significant aspects, they continue to perform admirably.

F-5 FREEDOM FIGHTER/TIGER

Introduced in the 1960s, the Northrop F-5 family of lightweight, agile, supersonic jets marked a significant advancement in military aviation. The initial variants, including the F-5A/B Freedom Fighter, took flight in the late 1950s, paving the way for later models, such as the F-5E/F Tiger II, which debuted in the early 1970s.

Initially embraced by the U.S. Navy, the F-5 found widespread adoption among American allies worldwide, including the Republic of China Air Force and the Republic of Korea Air Force. The aircraft's appeal lay in its blend of cost effectiveness, high performance, and ease of maintenance, making it a preferred option over heavier and more challenging-to-maintain models, such as the McDonnell Douglas F-4 Phantom II.

Designed to meet the demands of modern aerial warfare, the F-5 series offered a streamlined and efficient platform capable of delivering potent combat capabilities. It can reach speeds of Mach 1.4, fly up to 50,000 feet, and has a combat range of 600 miles. Examples of the multiple variants are the F-5A/B Freedom Fighter, F-5C Skoshi Tiger, F-5E/F Tiger II, and F-5E Tiger 2000.

During the Cold War, the United States exported F-5s to friendly nations, under a military assistance program supporting air defense, leading to its nickname Freedom Fighter. These nations included Canada, Greece, Iran, Norway, South Korea, Spain, Taiwan, Thailand, and Turkey. About two-thirds of those currently operating the F-5 also operate F-15s, F-16s, F/A-18s, and/or Dassault Mirage supersonic jets. In this context, the F-5 has in many cases shifted from fighter to trainer, with structural life extension programs and avionics/subsystems upgrade packages supporting this role.

F-16 FIGHTING FALCON

The General Dynamics/Lockheed Martin F-16 Fighting Falcon, affectionately known as the "Viper," stands as one of the most widely utilized legacy fighters in the world. This iconic fighter jet has undergone a remarkable evolution from its original lightweight, daytime interceptor design to a versatile multirole combat platform capable of all-weather operations, air-to-air combat, and air-to-ground attacks.

Today's F-16 belongs to the fourth generation of fighters, trailing only behind state-of-the-art stealth aircraft such as the F-35 Lightning and F-22 Raptor. Boasting impressive combat capabilities within a cost-effective and adaptable framework, the F16V offers a large-format, high-resolution display, active electronically scanned array (AESA) radar, modern avionics subsystems, efficient data bus and link, precision GPS system, ground collision avoidance system, sniper targeting pod, and lethal weaponry.

In a significant development in 2021, Lockheed Martin secured a contract worth approximately $14 billion from the U.S. Air Force, representing five foreign military partners. The contract aimed at constructing 128 F-16Vs Block 70/72 aircraft by 2026. Ongoing delivery and production of these fighters continues.

Ukraine also is poised to receive F-16 fighter aircraft from the United States and other nations, a crucial upgrade that both Kyiv and its Western allies anticipate will help balance the scales against Russia's formidable air force. However, the impact of these F-16s on the conflict in Ukraine will hinge on the ability of Ukraine and its partners to establish and sustain the extensive support and logistics infrastructure necessary to keep these advanced warplanes operational. (For more on F-16s anticipated by Ukraine, see the article on that nation in this publication.)

In February, the United States forwarded draft letters of offer and acceptance to Turkey, addressing its request to procure Block-70 F-16 fighter jets along with modernization kits. This request was submitted by Turkey in October 2021, following the United States's decision two years prior to exclude Turkey from the fifth-generation F-35 fighter jet program, due to its acquisition of a Russian missile defense system. U.S. leaders eventually consented to the delayed deal after a series of negotiations, particularly following Ankara's endorsement of Sweden's NATO membership bid. Formally notifying the U.S. Congress of its intent in January, the Biden administration has paved the way for the $23 billion sale. Turkey stands as one of the primary operators of F-16s, boasting a fleet comprised of over 200 older Block 30/40/50 models.

WORLD FIGHTER FLEETS

Following is a list of the total numbers of legacy fighter aircraft in worldwide fleets at the time of this writing.

MCDONNELL DOUGLAS F-4 PHANTOM

Greece	Hellenic Air Force	33
Iran	Islamic Republic of Iran Air Force	63
South Korea	Republic of Korea Air Force	19
Turkey	Turkish Air Force	19

NORTHROP F-5 FREEDOM FIGHTER/TIGER

Brazil	Brazilian Air Force	43
Chile	Chilean Air Force	13
Honduras	Honduran Air Force	5
Iran	Islamic Republic of Iran Air Force	35
Kenya	Kenya Air Force	23
Mexico	Mexican Air Force	4
Morocco	Royal Moroccan Air Force	25
South Korea	Republic of Korea Air Force	80
Switzerland	Swiss Air Force	53
Taiwan	Republic of China Air Force	27
Thailand	Royal Thai Air Force	34
Tunisia	Tunisian Air Force	11
Yemen	Yemen Arab Republic Air Force	11

GENERAL DYNAMICS–LOCKHEED MARTIN F-16 FIGHTING FALCON

Bahrain	Royal Bahraini Air Force	17
Belgium	Belgian Air Component	44
Bulgaria	Bulgarian Air Force	16 on order
Chile	Chilean Air Force	46
Denmark	Royal Danish Air Force	30
Egypt	Egyptian Air Force	240
Greece	Hellenic Air Force	151
Indonesia	Indonesian Air Force	33
Iraq	Iraqi Air Force	34
Israel	Israel Air and Space Force	175
Jordan	Royal Jordanian Air Force	72
Morocco	Royal Moroccan Air Force	23
Oman	Royal Air Force of Oman	22
Pakistan	Pakistan Air Force	75
Poland	Polish Air Force	48
Portugal	Portuguese Air Force	28
Romania	Romanian Air Force	23
Singapore	Republic of Singapore Air Force	60
Slovakia	Slovak Air Force	14 on order
South Korea	Republic of Korea Air Force	167
Taiwan	Republic of China Air Force	140
Thailand	Royal Thai Air Force	50
Turkey	Turkish Air Force	235
UAE	United Arab Emirates Air Force	78
United States	United States Air Force	875
Venezuela	Venezuelan Military Aviation	15

Sources: "Air Force opens new F-16 production line for foreign military sales, May 2021," U.S. Air Force, www.af.mil; Elisabeth Gosselin-Malo, "F-4 Terminator Phantoms Still Going Strong at Turkey's Anatolian Eagle Exercise" *The War Zone*, May 2023, www.twz.com.;; Unshin Lee Harpley, "South Korea's F-4 Phantoms Fire AGM-142 Missiles One Last Time," *Air & Space Forces Magazine*, April 2024, www.airandspaceforces.com.; Jon Jackson, "Ukraine to Receive Expedited Delivery of F-16s," April 2024, *Newsweek*, www.newsweek.com.; Lara Jakes, "Ukraine Could Deploy F-16s as Soon as July 2024, but Only a Few" March 2024, *The New York Times*, www.nytimes.com.; "Meet F-16V: The Most Technologically Advanced 4th Generation Fighter in the World," Lockheed Martin, www.lockheedmartin.com; "Turkey receives U.S. draft letters approving F-16 deal," February 2024, Reuters, www.reuters.com.

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TIDBITS

A PAC JF-17 at the 2015 Paris Air Show in June 2015. (Image courtesy of the U.S. Air Force.)

THE OLD FALCON FENDS OFF A NEW DRAGON

From its inception, the General Dynamics F-16 Fighting Falcon (now produced by Lockheed Martin) has faced great expectations of—and often, stiff competition for—sales to foreign nations. And with more than 4,600 built over the course of its 50-year history and the ongoing production of newer variants to compete in the export market, it is fair to assume that the F-16 will continue to be a viable choice for foreign buyers for a long time to come.

But 50 years is a long time for any product to hold its own against its competition, and the F-16 is now competing for sales to foreign nations that have also expressed interest in an aircraft jointly developed by China and Pakistan: the Pakistan Aeronautical Complex (PAC) JF-17 Thunder "joint fighter," also released as the Chengdu Aircraft Corporation (CAC) FC-1 Xiaolong.

The PAC JF-17 is designed to augment Pakistan's aging inventory of aircraft. The Pakistan Air Force has long relied on the Falcon as its primary fighter, and it has continued to negotiate new purchases of F-16s from the United States, even as it increased production of the JF-17. The nation's air defense arm counts an estimated seventy-five F-16s and more than 150 JF-17s in inventory.

For the CAC, the FC-1 was designed primarily with export sales in mind, as China has other options for adequately equipping its own forces. The marketing emphasis on the part of the CAC is evident in everything from the company's name for the aircraft ("Xiaolong" translates to "Fierce Dragon" in English) to its price tag (generally estimated at $25 million, depending on model and upgrades). The FC-1 is aimed at the low end of the market, where countries unable to equip their air arms with more expensive options, even via the purchase of older aircraft, or at a great discount from a friendly ally, might be attracted by an affordable, adaptable new type. Despite differences in market focus, procurement, maintenance cost, capability, and adaptability, competition between the Falcon and the Dragon has yielded some surprising results.

In mid-2023, it was reported that Iraq had, after years of rumored negotiations, committed to the purchase of twelve JF-17s for a total of $664 million, as part of its plans to replace its current fleet of F-16s. Argentina also expressed interest in the JF-17 over a period of several years, beginning in 2015. However, the potential purchase was derailed in October 2023, when the Biden administration signaled U.S. approval for Argentina to instead acquire older F-16s from Denmark.

Sources:
Franz-Stefan Gady, "Report: JF-17 'Thunder' Block III Fighter Jet Production Is Underway," *The Diplomat*, March 2019, thediplomat.com; Paul Iddon, "Iraq might Buy Pakistan's JF-17 Fighter Or France's Rafale, Or Both," *Forbes*, July 2023, www.forbes.com; Ricardo Meier, "Argentina chose the F-16 fighter for its Air Force-reports," *Air Data News*, January 2024, www.airdatanews.com; "Pakistan meets JF-17 production target," *Pakistan Express Tribune*, December 2015, tribune.com.pk/pakistan; "U.S. Approves Proposed F-16 Transfer To Argentina," *Aviation Week*, October 2023, aviationweek.com.

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TIDBITS

As a U.S. Air Force fighter pilot, Major General Jeannie Leavitt accumulated over 300 combat flight hours in the McDonnell Douglas F-15E Strike Eagle. (Image courtesy of the U.S. Air Force.)

FIRST FEMALE FIGHTER PILOTS INSPIRE FUTURE FIGHTERS

When U.S. Air Force Chief of Staff Merrill McPeak announced on April 28, 1993 that the service had reconsidered its longstanding "combat exclusion" rule prohibiting women aviators from serving in combat roles, he also introduced three women who would, as a result of the change in policy, be trained as Air Force fighter pilots. Jeannie Leavitt (then known by her maiden name Jeannie Flynn), Sharon Preszler, and Martha McSally would fulfill the promise of the historic opportunity they were given that day.

At the time of the change in policy, Leavitt was undergoing undergraduate pilot training with the goal of becoming an instructor pilot in the Northrop T-38 Talon trainer aircraft. She completed combat training in the McDonnell Douglas F-15E Strike Eagle, and then went on to accumulate more than 300 combat hours in the F-15, while also taking on assignments of increasingly larger responsibility throughout the course of her trailblazing career, ultimately rising to the rank of major general.

Preszler's long service as a fighter pilot is most closely associated with the General Dynamics F-16 Fighting Falcon (now produced by Lockheed Martin), also known as the Viper. Over the course of her two decades of U.S. Air Force service, she became the first female pilot of a F-16, accumulating more than 1,300 hours flying time, including more than 50 combat hours as the Viper's first-ever female combat pilot. She was also the first female F-16 instructor, and retired from the service as a lieutenant colonel in 2006.

McSally first flew in combat as pilot of a Fairchild Republic A-10 Thunderbolt II, also known as the Warthog, in Iraq during Operation Southern Watch in 1995. In 2004, she became commander of the 354th Fighter Squadron; in that capacity, she was deployed to Afghanistan during Operation Enduring Freedom. By the time she concluded her 22-year career in the U.S. Air Force in 2010, she had attained the rank of colonel. She then continued her public service as a representative of Arizona's 2nd congressional district in the U.S. House of Representatives from 2015 to 2019, and as a U.S. senator from Arizona from 2019 to 2020.

In the decades since that decisive moment when women could, for the first time, compete for combat roles alongside their male counterparts, the power of the examples set by Leavitt, Preszler, and McSally—and the unique nature of their achievements—is evident in the dreams and careers of subsequent generations. As of 2023, the U.S. Air Force counted 103 female fighter pilots among its total of more than 10,000 pilots.

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Carl Bergquist, "Air Force Lt. Col. Martha McSally–First female pilot in combat reflects on career," U.S. Air Force news release, Maxwell Air Force Base, December 2006, www.af.mil; Al Bravo, "First female combat pilot completes training," *Associated Press,* February 1994, apnews.com; Maria Galvez, "A tale of two generations of women in combat aviation," U.S. Air Force news release, Joint Base Elmendorf-Richardson, March 31, 2023, www.af.mil; Rachel Martin, "First Female Fighter Pilot: 'Attention Wasn't What I Wanted,'" NPR Sunday Conversation, May 2013, www.npr.org; "Sharon 'Betty' Preszler," Athena's Voice, athenasvoiceusa.com; "Sharon "Betty" Preszler–Keynote Speaker," National Wasp World War II Museum, December 2022, www.waspmuseum.org; Tarsha Storey, "First female active-duty fighter pilot retires," U.S. Air Force news release, Shaw Air Force Base, October 2006, www.airforce.com; U.S. Air Force, "Major General Jeannie M. Leavitt," www.af.mil; "Women in Combat," April 28, 1993 video, C-SPAN, www.c-span.org.

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An MQ-9 Reaper Remotely Piloted Vehicle (RPV) in the sky over Hancock Field Air National Guard Base in New York in December 2015. (Image courtesy of the U.S. Air Force.)

WHEN THE VIPER MEETS THE REAPER

For an airframe that flew its first flight in 1974, the General Dynamics F-16 Fighting Falcon (now produced by Lockheed Martin), affectionately known as the Viper, is aging remarkably well. Over the course of its five decades of U.S. Air Force service, the F-16 has proven itself as near to indispensable as any fighter in history. This achievement is acknowledged by the Post Block Integration Team (PoBIT) upgrade program, begun in 2022 and designed to extend the F-16's service life into the 2040s.

Given its versatility and low cost, the Viper has long been prized as a force multiplier capable of adapting to a variety of roles for which other aircraft are less well suited. But even with U.S. Air Force's F-16s slated to receive the modifications necessary for two more decades of successful service, the question remains of what will one day replace the F-16. In one case, this question has already yielded a surprising answer.

Based at Hancock Field in Syracuse, New York, the 174th Attack Wing of the New York Air National Guard (ANG) received its first F-16s in 1988. The aircraft were initially designated "F/A-16" due to their unique mission, testing the Viper's suitability for close air support (CAS). The pilots of the 174th were prepared for this challenge, as they had been operating the Fairchild Republic A-10 Thunderbolt II, affectionately dubbed the Warthog, in CAS missions since 1979.

The F-16 quickly became a fixture at Hancock Field, and the pilots of the Wing's 138th Attack Squadron flew the aircraft in deployments around the globe over the course of the next twodecades. Missions included combat operations during Operation Desert Storm in 1991 and the Global War on Terrorism in 2006 and 2008. But by the late 2000s, the rapidly changing character of air conflicts again led the U.S. Air Force to leverage the experience and expertise of the 174th to test the efficacy of a novel approach to modern air warfare operations.

In 2009, the F-16s stationed at Hancock Field, assigned to what was then known as the 174th Fighter Wing, were replaced by General Atomics MQ-9 Reaper unmanned Remotely Piloted Vehicles (RPVs) manufactured by General Atomics Automated Systems of Poway, California. With this transition, the 174th became the first ANG unit to operate the MQ-9, and their division was rechristened the 174th Attack Wing.

In the years since, the MQ-9 has found Hancock Field as suitable a home as its predecessor. And the pilots of the 174th have ably adapted to their new role, which has included the Reaper's combat deployment to Afghanistan as part of Operation Enduring Freedom.

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TIDBITS

The secrecy surrounding the development and deployment of the highly classified Lockheed F-117 Nighthawk, seen here during a September 2021 training exercise with the 144th Fighter Wing of the California Air National Guard, helped fuel intense curiosity about the aircraft. A kit that portrayed a model maker's estimate of the Nighthawk's appearance, marketed as the "F-19 Stealth Fighter," became a must-have collectible for hobbyists. (Image courtesy of the U.S. Air Force.)

MODEL BEHAVIOR: THE "F-19 STEALTH FIGHTER"

Where national defense and pop culture intersect, the process of developing a new military aircraft at America's top defense contractors is mirrored by the efforts of a different sort of development team: model designers at the nation's leading hobby manufacturers. Companies such as the Testor Corporation (familiarly known as Testors and headquartered in Rockford, Illinois) and Revell GmbH (Bünde, Germany) meticulously replicate aircraft in the U.S. arsenal with scale model replicas, aimed at the educational toy market and adult aircraft enthusiasts.

The resulting model airplane kits for models such as the General Dynamics (now Lockheed Martin) F-16 and the McDonnell Douglas (now Boeing) F-15 allow hobbyists to assemble and paint miniature plastic versions of iconic aircraft that have become familiar via media coverage or appearances at air shows or military bases. Sometimes, a model even gets out in front of the real thing.

Such was the case with the Lockheed F-117 Nighthawk. The earliest real-world incarnation of an aircraft that incorporated modern stealth technology and materials, the F-117 was a closely held secret throughout its multiyear development and for the first five years after its introduction into U.S. Air Force service in October 1983. But while the specifics of the F-117 were known only to a small group of individuals at Lockheed and within the military establishment, there was a general anticipation among the broader aviation and military communities that a stealth aircraft was the logical next step in the development of U.S. air power. In the wake of the public development and introduction of the F-15, F-16, and the McDonnell Douglas F/A-18 Hornet, there was a general assumption among industry watchers and analysts that there would be a next-generation "F-19" stealth fighter.

In response to speculation about what the new aircraft might look like, Testors issued a scale model kit dubbed the "F-19 Stealth Fighter" in January 1986. The model was based on information publicly available, combined with the best estimations of the company's design staff, who drew on decades of experience dating back to the model maker's founding in 1929.

While the existence of the actual F-117 Nighthawk was not confirmed by the U.S. Air Force until November 1988, the model kit helped fuel frenzied interest in the then still highly classified aircraft. CBS Evening News covered the release of the kit, and several news organizations even used images of the model for coverage of a crash of an actual F-117 in July 1986. (The crash site was kept off limits to the media, with all traces of the aircraft removed before public access to the area was reestablished.)

When details about the Nighthawk ultimately were made public, various inaccuracies of the "F-19" model kit were obvious. But the intense interest generated by the secrecy surrounding the real-life F-117 and its tiny plastic doppelganger reportedly helped make the F-19 the most successful scale model kit of all time, enabling Testors to increase early production of the sought-after kit to 600,000 units.

Sources:
Paul Ciotti, "Tempest in a Toy Box," *Los Angeles Times*, October 1986, www.latimes.com; Don Logan, *Lockheed F-117 Night Hawks: A Stealth Fighter Roll Call.* Atglen, PA: Schiffer Military History, 2009; "Lockheed F-117 Nighthawk," Dayton, OH: National Museum of the United States Air Force, Wright-Patterson Air Force Base, www.nationalmuseum.af.mil.

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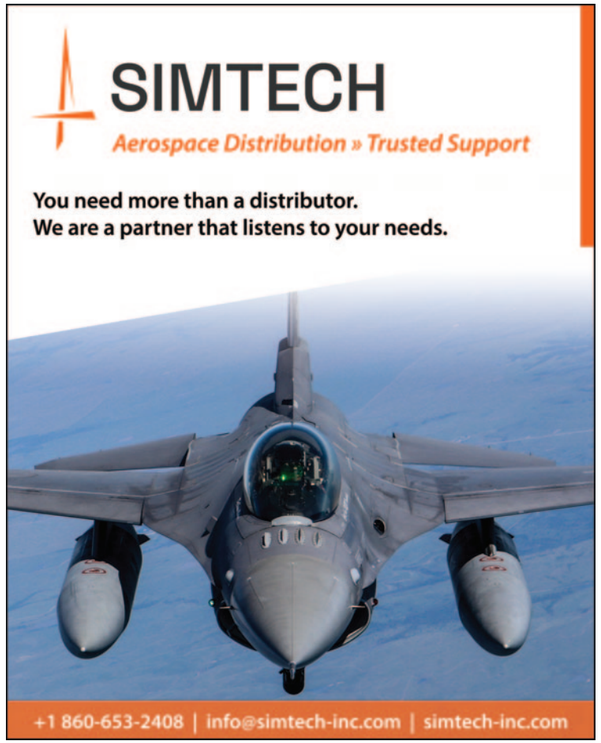

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