AerospaceDaily & DEFENSE REPORT

AVIATION WEEK Intelligence NETWORK

The Business Daily of the Global Aerospace and Defense Industry Since 1963

August 21, 2020

Inside:

NRO Launch

A United Launch Alliance Delta IV Heavy is scheduled to launch a classified satellite for the National Reconnaissance Office during a launch window that opens Aug. 26 at 2:16 a.m. eastern time. The payload for the mission, NROL-44, was delivered to Cape Canaveral's Space Launch Complex-37 on July 27 and mounted atop the Delta IV. The rocket, which stands 235 ft. (72 m) tall, can carry 6,580 kg (14,500 lb.) to geosynchronous orbit.

Daily Briefs

THC of Saudi Arabia signed purchase agreement for 10 **AIRBUS** H125 helicopters.

TOYON RESEARCH CORP. has $8.7m U.S. Air Force contract for algorithm development for resilient on-orbit image processing.

FRANCE's DGA announced successful first refueling test flight between A400M Atlas and a Caracal helicopter in late July.

AIRBUS HELICOPTERS delivered first of 16 new H125 helicopters configured for U.S. Customs and Border Protection Air and Marine Operations.

BAE SYSTEMS will buy UK-based data consultancy/digital services company **TECHMODAL**.

TECHNOLOGY

AI Dominates Human F-16 Pilot In Mock Dogfights

STEVE TRIMBLE, steve.trimble@aviationweek.com

An artificial intelligence (AI) "agent" named Falco flying a simulated F-16 roundly defeated an experienced U.S. Air Force pilot in a simulator Aug. 20 in the Alpha Dogfight sponsored by DARPA.

The AI program, developed by Alpha Dogfight finalist Heron Systems won all five mock fights against the human-controlled aircraft, rendering the fighter pilot obviously confused after the first four defeats.

"The kind of standard things we do as fighter pilots are not working. For this last one I'll try to change it up a little bit, just to do something different," said the F-16 pilot, who was identified by the call sign "Banger."

By the time the human pilot joined the competition, Heron Systems, a small company based in Maryland, already had dominated all other teams participating in the Alpha Dogfight trials since Aug. 18, including a lopsided semi-final victory over an AI system developed by Lockheed Martin.

The final competition pitted the AI system versus the human pilot in a series of five neutral set-ups, involving only guns within visual range in basic fighter maneuvers. Heron Systems' Falco agent adopted a particularly aggressive, head-on pointing style in simulated aerial battles. Some of the maneuvers likely would have been outlawed on safety

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DOGFIGHTS, From P. 1

grounds in live training by human pilots flying real aircraft, but the AI agent operated with different rules and with a perspective clearly undeterred by a human's survival instinct.

Another advantage came in how Heron Systems designed the update rate for the control inputs by the AI agent. Whereas most of the AI competitors in the trials used a 50-Hz rate, Heron Systems adopted a more rapid 10-Hz rate. Such an update rate may cause pilot-induced oscillations by a human controller, but fell within the control envelope of the AI agent.

"We were able to make some of those high-aspect shots and keep that machine-level targeting of our opponents," said Ben Bell, Heron Systems' senior machine learning engineer.

The competition, which was broadcast live on YouTube, completes the year-long DARPA experiment. Heron was one of eight teams selected to participate in the finals last fall, but emerged as one of the early leaders, along with Lockheed. In a series of demonstrations this spring, Heron's Falco system scored roughly evenly with Lockheed's AI system in mock dogfights. Both teams adopted an aggressive, head-on dogfighting style, but Heron's came out on top.

"[Lockheed was] perfectly fine going head-to-head [with us]," Bell said. "It's just that their control over the stick-and-rudder wasn't as fine as ours."

In the semi-final match with Lockheed's AI system, Falco actually erred as it began each dogfight, catching Bell's team by surprise. In a head-on engagement, basic fighter maneuvers dictate that both aircraft turn-in on each other, but the Falco-controlled aircraft turned outward and climbed.

"So we're losing all of our energy just trying to make it around to the second merge, where we're actually neutral [again]," Bellexplained. "And really the only reason that we won there is we have better aiming, so we're able in that first merge to take the shot and get the win."

Heron Systems now plans to move the Falco agent outside the simulator and into real unmanned aircraft vehicles (UAVs), Bell said.

"One of the biggest next steps for us is going to be converting this agent into something that can run on an actual UAV flying in the real world," Bell noted. "We will prove to people that, hey, we can apply this, and we can show that these agents can transfer from the simulator to a real aircraft."

PROGRAMS

DOD Official: F-35 Sale To Poland May Quicken Future Deal Closings

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The sale of Lockheed Martin F-35s to Poland paves the way for future Joint Strike Fighter deals to close within six months of the initial agreement, according to the Pentagon acquisition executive.

Defense trade modernization is a "key initiative" for Defense Secretary Mark Esper because the U.S. wants to support its partners and allies by supplying equipment, Ellen Lord, the Defense Department (DOD) undersecretary for acquisition and sustainment, told reporters Aug. 20. It is helpful for U.S. partners and allies to have interoperable equipment while also blocking Russia from selling its platforms, she explained.

Intended purchase

Poland announced last summer it intended to purchase F-35As. The NATO ally signed a contract for 32 of the jets in January.

"I think the Poland effort really shows what happens when all the agencies, such as [Defense Security Cooperation Agency (DSCA)] and other DOD components, work very closely with the State Department," Lord said.

Classified briefing

The New York Times reported Aug. 19 the Air Force provided a classified briefing on the F-35 to the United Arab Emirates. When pressed if selling F-35s to the UAE is on the table, Lord deferred to the State Department.

"I will say I've spent quite a bit of time in the region over the years in this role actively talking about F-16 upgrades. That has been an ongoing discussion that DSCA and the Air Force have worked on," Lord said.

Separately, Lord plans to visit NAS Patuxent River, Maryland, next week to view the F-35 Joint Simulation Environment (JSE). She said the Pentagon anticipates the F-35 will enter full-rate production in March 2021.

"There have been setbacks within the JSE from COVID. It is a very close working environment" Lord said.

The purpose of Lord's visit is to understand where the team is in the test program and ensure the program has the resources it needs, she added.

PROGRAMS

NASA To Evaluate Blue Origin Human Lunar Lander Hands-On

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HOUSTON—NASA took delivery Aug. 20 of a Blue Origin-led mockup of one of three commercial lunar Human Landing System proposals critical to achieving a White House directive of returning human explorers to the Moon in 2024.

Blue Origin's partners in the effort are Lockheed Martin, Northrop Grumman and the Draper Laboratory.

The combined 40-ft.-plus structure housed in the NASA Johnson Space Center's (JSC) Space Vehicle Mockup Facility includes the Blue Origin lander and the Lockheed ascent module that is expected to house NASA's Artemis astronaut crews during their initial weeklong lunar sorties.

The mockup, which is to remain here at JSC through early 2021, is to support engineering and astronaut-corps interactions and evaluations.

The Blue Origin-led lander system also is to include a Northrop Grumman Transfer and refueling element, which will shuttle the lander from lunar orbit to a low lunar altitude once astronauts launched from Earth arrive aboard NASA's Space Launch System and Orion capsule.

The Blue Origin "National Team," SpaceX and Dynetics each were awarded 10-month base-period contracts by NASA on April 30 to permit deeper NASA involvement in assessing the competing proposals. Their prices ranged from Blue's $579 million to Dynetics' $253 million and SpaceX's $135 million.

"We believe the national team combines the best of breed from all the talent within the U.S.," said Sally Richardson, Northrop Grumman's transfer element program manager.

Draper's contributions to the Blue Origin effort include guidance, navigational control, avionics and software—elements with a legacy involvement by the Cambridge, Massachusetts, company dating back to the Apollo program.

The Blue Origin descent element is based on the company's Blue Moon cargo lander and BE-7 liquid-oxygen/hydrogen rocket engine, each under development for more than three years.

Lockheed's Ascent element incorporates life-support and crew interfaces from the company's Orion crew module as well as avionics and software.

And Northrop Grumman's transfer element draws from the company's development, operational and upgrade experience with the Cygnus International Space Station resupply capsule, which has flown 13 cargo missions to the orbiting science lab.

FUNDING & POLICY

Five Companies Eligible To Sell Small UAS To U.S. Government

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By the end of September, the Pentagon will have cleared five companies—Altavian, Parrot, Skydio, Teal and Vantage Robotics—to sell their small unmanned aircraft systems (sUAS) to the U.S. government.

For 18 months, the Defense Innovation Unit (DIU) and the Army's short-range reconnaissance program focused on purchasing sUAS worked together to clear an inexpensive, rucksack-portable, vertical-takeoff-and-landing system for small units.

China has dominated the sUAS market so the U.S. effort was focused on establishing domestic alternatives.

DIU dubbed its spinoff Blue sUAS, building off the Army's initial success. It provides alternative ground-control and radio configurations that can accommodate users across the federal government.

"Blue sUAS showcases how we can both work with small, nontraditional companies and our allies and partners to quickly pilot cutting-edge technologies that support our mutual defense," Michael Kratsios, acting secretary of defense for research and engineering, said in an Aug. 20 statement.

The sUAS will be available from the General Services Administration, or the military can purchase them using other transaction authority.

"Blue sUAS is a great example of Defense Department (DOD) acquisition reform by lowering the barrier to entry for non-traditional companies to rapidly iterate shoulder to shoulder with warfighters to deliver highly capable sUAS tailored to mission needs," said Ellen Lord, undersecretary of defense for acquisition and sustainment, in an Aug. 20 statement.

Separately, on the same day, the Pentagon confirmed to Aerospace DAILY the $13.4 million awarded under Defense Production Act Title III in July to support the sUAS industrial base is an unrelated effort.

That funding is spread across five companies via the Coronavirus Aid, Relief and Economic Security (CARES) Act to enhance military personnel situational awareness, improve human-machine teaming and provide engineering support for sUAS integration. The contracts were issued through DIU.

The CARES Act funding saved 14 jobs and created 20 new positions, according to the Pentagon. The bulk of the funding—$4 million—went to Skydio of Redwood City, California, to help improve

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PROGRAMS

Hypersonic Mayhem Linked To 'Multi-Cycle' Air-Breathing Engine

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The new Mayhem demonstrator vehicle for a hypersonic, air-breathing propulsion system traces back to budget planning documents that describe a proposal to develop "multi-cycle engines," the U.S. Air Force Research Laboratory (AFRL) confirmed to Aerospace DAILY.

The acknowledgment is the clearest indication that Mayhem will serve as a testbed for dual-mode or turbine-based combined cycle (TBCC) hypersonic propulsion systems.

AFRL first disclosed Mayhem in a request for information published on Aug. 12 for an "Expendable Hypersonic Multi-Mission Air-Breathing Demonstrator." The Air Force seeks a new vehicle capable of hosting at least three different payloads on each flight.

No demonstrator by that name appears in Air Force budget documents, but a spending justification report published in February does name an effort to launch a program called the "Multi-Mission Cruiser."

"Mayhem, in its early planning stages, was described as a 'Multi-Mission Cruiser' due to the focus on sustained hypersonic flight capabilities independent of potential payloads," AFRL said in response to emailed questions.

The justification report describes the Multi-Mission Cruiser as featuring a "multi-cycle" propulsion system. The Air Force also is pursuing an operational prototype of a scramjet-powered cruise missile, as a follow-on to the Defense Advanced Research Projects Agency's Hypersonic Air-breathing Weapon Concept (HAWC). But the HAWC follow-on will use a single-cycle scramjet engine.

By contrast, the Mayhem vehicle is "focused on demonstrating advanced scramjet propulsion technologies," AFRL said, but did not confirm whether "multi-cycle" refers to either a TBCC or dual-mode scramjet engine.

FUNDING & POLICY

SpaceX Still Pursuing Lawsuit Against U.S. Air Force

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SpaceX is sticking by its lawsuit against the U.S. military for its decision not to award it one of three design and development contracts awarded two years ago, saying the decision has inflicted "substantial harm" on the California-based company.

SpaceX still wants to rectify that harm, even though it recently won a substantial share of the service's national security space launches to be purchased over the next four years.

SpaceX initially filed the lawsuit in 2018, after the Air Force awarded Launch Service Agreements to three companies: Blue Origin was to design and develop its New Glenn rocket; Northrop Grumman to create the Omega launcher; and United Launch Alliance (ULA) to make the Vulcan. The Air Force maintained that those awards did not preclude other companies—including SpaceX, which had proposed to use its Falcon fleet and the future Mars-class Starship (previously known as the Big Falcon Rocket)—from winning eventual launch service contracts.

That proved true. On Aug. 7, the U.S. Space Force's Space and Missile Center (SMC) along with the National Reconnaissance Office granted SpaceX and United Launch Alliance (ULA) contracts worth billions of dollars for medium- and heavy-lift launch services that will be bought through fiscal 2024. SpaceX will receive 40% of the missions and ULA 60%.

SpaceX will continue to pursue its lawsuit, arguing that the 2018 agreement may have given ULA an unfair advantage. In a notice to the U.S. District Court for the Central District of California filed on Aug. 19, SpaceX said that while the Aug. 7 Launch Service Agreement (LSA) Phase 2 award has "mitigated the harm to SpaceX resulting from the unlawful and flawed LSA award decisions, substantial harm to SpaceX remains."

SpaceX, the notice continues, competed for that Phase 2 contract without the benefit of government funding and technical information exchanges that may continue to advantage ULA in future competitions and is asking SMC to "rectify" its competition errors. SpaceX said that will not slow down future launch services.

But the U.S. and SpaceX's competitors ULA and Northrop Grumman—whose initial agreement will be halted after losing the Phase 2 award—say SpaceX's bid for money under the initial LSA agreement is invalid. SpaceX's LSA proposal included launch services with a Big Falcon Rocket. For Phase 2, SpaceX offered only the Falcon 9 and Falcon Heavy, thereby invalidating its claim to funding under the LSA, SpaceX's opponents in the case said. A response by Blue Origin was not included in the court notice.

The U.S. and ULA also argue that if the court sides with SpaceX, it is likely to harm national security, adding that if ULA's launch service agreement were vacated, the loss of development funding could delay the readiness of ULA's planned Vulcan rocket.

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BUSINESS

Urban Aeronautics Partners With Air Ambulance Operator On VTOL

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Israel's Urban Aeronautics has signed an agreement with U.S.-based emergency air transport provider Hatzolah Air to develop a version of its CityHawk air taxi for emergency medical service applications.

Hatzolah Air, or HatzolAir, is non-profit organization formed to provide, arrange and fund air transportation for medical, humanitarian and disaster relief, and other charitable purposes. Part of a worldwide volunteer ambulance organization, HatzolAir began operations in 2019 with a Learjet 60.

Tailor made

Under the memorandum of understanding, HatzolAir will partner with Urban to tailor the planned CityHawk vertical-takeoff-and-landing (VTOL) vehicle to its emergency medical service (EMS) requirements. The companies expect the aircraft to be FAA-certified in 3-5 years.

Equipped with dual enclosed rotors, the CityHawk is compact enough to land in a city street, "making it a perfect fit for medical evacuation missions by dramatically decreasing the time it takes to arrive on the scene," Urban CEO Ravi Yoeli said in a statement.

In the EMS mission, the twin-engine CityHawk will be designed to carry a pilot, one patient plus a companion, two emergency medical technicians and a complete package of life-support equipment.

The 3,900-lb.-gross-weight aircraft is to be powered by a pair of 985-shp. Safran Helicopter Engines Arriel 2N turboshafts, although Urban is planning a later version with hydrogen fuel-cell propulsion.

The CityHawk is based on the Cormorant ducted-fan VTOL unmanned cargo aircraft, which, according to Urban, has completed more than 300 test flights in Israel with support from the defense ministry.

Funding commitment

The agreement with HatzolAir includes a funding commitment in the form of down payments on pre-orders for the EMS CityHawk, Urban said. HatzolAir also will lead worldwide marketing of the CityHawk to EMS and rescue organizations under a distribution agreement with the Israeli company.

Urban is raising funds privately for full-scale development (FSD) of the CityHawk. "At some point, perhaps as soon as next year, [the company] may go public to raise the full amount to take the program through FSD to certification," a spokesperson told Aerospace DAILY.

"This effort will most likely be combined with a strategic partnership with one of the aerospace OEMs. We are working on all these fronts, while advancing on the design of the aircraft," the spokesperson said. The MoU with HatzolAir involves Besnado Group, an Israeli-American investment firm that is one of Urban's largest backers.

TECHNOLOGY

FlyZero Study To Position UK Industry For Role On Net-Zero Airliner

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The UK's year-long FlyZero feasibility study will help position its industry to participate in developing a zero-carbon emissions commercial aircraft for the 2030s, according to the country's Aerospace Technology Institute (ATI).

The technical and commercial issues behind developing a net-zero-carbon airliner by the end of the decade will be explored by a 110-strong team seconded from industry and academia, the ATI explained in an Aug. 12 webinar detailing the program.

Led by the ATI, the feasibility study could lead to demonstrator programs that position the UK industry to provide key technologies for an aircraft that could be developed as a national "moonshot," or, more likely, through international collaboration.

"We're not looking to produce an aircraft out of this piece of work," ATI chief technology officer Simon Weeks said. "We're looking to see what is the most likely commercial zero-net-carbon aircraft in the 2030s. And what additional the UK needs to do to be ready for that. What demonstration projects we need to launch downstream of this study."

The ATI, which manages the UK government's multi-year investment in civil aviation research, plans to begin recruiting within the next month and have the first 25 members of the FlyZero team in place six to eight weeks later. The remaining 80 or so are to follow within two months.

The project has three aims, ATI CEO Gary Elliott said. The first is to understand the major technical and commercial issues in bringing a net-zero airliner to market. The second is to establish the industrial economic business case for future research and technology investments.

The third aim is to sustain and develop key capabilities for the UK aerospace sector. "This is about developing even greater knowledge and understanding of the potential technologies used to achieve zero-carbon-emission flight," Elliott said.

FlyZero will have five high-level workstreams: business management for the fast-paced project; sustainability, to ensure net zero is achieved; strategy and commercial, looking at economic viability; technical, developing design options and models; and manufacturing, lifecycle and supply chain.

Weeks said the project will have three stages: "an initial study phase, followed by concept trades, and then the preliminary design stage which will get us an output from the project." FlyZero is focused on aircraft with more than 80 seats—large regionals and single-aisles, with a longer-term look at twin-aisles.

The initial study will collect the information that is known already on how to get to net-zero-carbon aviation. "We're going to pull that together and get that into a structure that can be understood by the team—ideas that we think are most appropriate," Weeks said. The concept trade study will pull those ideas into views of what aircraft and the systems within them might look like, how sustainable they would be and possible operational issues. This will give an idea of their economic viability and produce a high-level technology road map.

"Then we'll do a further downselect and go into the preliminary design stage. That might be one idea to go forward with in detail, it might be more than one," Weeks said. "The idea is to develop the concepts into more-detailed models to understand their performance [and sustainability]." This could result in major demonstrator projects as the next step beyond FlyZero.

A parallel academic program, meanwhile, will take fundamental research and technology needs identified in the concept trades phase and "go away and get some answers on those ... and bring them back in before the end of the overall FlyZero project," Weeks said. Weeks said these are the key questions the FlyZero study will answer: "What net-zero-carbon commercial airline is going to be the most likely in the 2030s? How many people will it carry, how far? How will it impact the transport system? And what does the UK need to do to be ready?"

UAS, From P. 3

its sUAS flight controller hardware/software and data link.

AirMap, located in Santa Monica, California, received $3.3 million for product development and engineering support for integration of sUAS mission planning, post-mission analysis and unmanned traffic-management software.

ModalAI, based in San Diego, won $3 million to develop its next-generation flight controller, which is intended to enable advanced autonomy instruments including GPS-denied navigation and all-environment obstacle avoidance.

Another San Diego company, Obsidian Sensors, received $1.6 million to build a low-cost, dual-thermal sUAS camera that can be mounted onto a stabilization gimbal to outfit small intelligence, surveillance and reconnaissance systems.

The only non-California company, Graffiti Enterprises, has been awarded $1.5 million. The company is based in Somerset, New Jersey, and is expected to modify its commercial data link for DOD sUAS operations in restricted-frequency bands. The company is expected to reduce the size, weight and power of the hardware, and develop software to improve data-link security and resiliency.

OPERATIONS

NTSB Counts Three Confirmed And Three Suspected Drone Collisions

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The NTSB has confirmed three midair collisions of drones with manned aircraft in the U.S. since 2017, and rates three other incidents as suspected drone collisions.

While midair drone collisions have not caused major accidents or fatalities, the FAA receives more than 100 reports of drone sightings by pilots, citizens and police each month—it lists more than 400 in its latest report, for the April-June period.

The U.S. Air Force's 89th Airlift Wing is reviewing witness reports that a drone passed near a C-32A (Boeing 757-200) operating as Air Force One and carrying President Donald Trump as it approached Joint Base Andrews, Maryland, on Aug. 16.

The NTSB studies all reports of collisions between drones and other aircraft and rates them informally as confirmed, plausible or "busted"—proven to have not involved a drone, says Investigator-in-Charge Bill English, the NTSB's unmanned aircraft systems (UAS) program lead.

"In many cases we can 'bust,' we can say this is not a drone at all," English told the online FAA UAS Symposium on Aug. 18. "Different types of events have occurred; usually they turn out to be a bird or wildlife strike."

The various incident reports require any of a series of investigative steps. They include searching the area below a reported collision, scanning social media for incriminating video, checking with aircraft-surveillance system companies and in-depth analysis of structures and materials.

In July, the NTSB announced a probable-cause finding that a drone likely struck an Airbus AS350B2 helicopter flying at 700-800 ft. above ground level over downtown Los Angeles on Dec. 4, 2019. Searchers found no drone following the incident, which slightly damaged a Helinet Aviation Services' newsgathering aircraft working for ABC7 News.

Examination of a dented portion of the helicopter's horizontal stabilizer using Fourier-transform infrared spectroscopy indicated that a polycarbonate polymer material—commonly used for drone structures—had rubbed off on the stabilizer skin surface. Magnification inside the dent revealed a small, circular indentation of 0.125 in., about the diameter of a propeller shaft on a small drone.

The NTSB also strongly suspects a drone collided with a single-engine Cessna 170 aircraft flying at 2,000 ft. in Class D airspace near Aurora State Airport, Oregon, on May 29, 2018.

"We sent that evidence back to the [NTSB] lab," English said. "The wingtip under examination did show it was damaged by something hard and dense. There was no evidence of any biological residue under the magnification or under ultraviolet light."

Analysis of the damaged part by the Wichita State University National Institute for Aviation Research, which conducts collision-dynamics modeling, indicated a drone was to blame.

"Their model was very consistent with the collision of a small drone and this type of aircraft structure at the moderate speeds that you would expect for a Cessna 170," said English. "Although we couldn't find a drone specifically, there's probably not another explanation. All the evidence definitely points to a drone."

A third plausible strike, with no drone recovered, involved a Blue Hawaiian Helicopters' Airbus EC-130B4 sightseeing helicopter flying near the Kauai Napali Coast in Hawaii on Feb. 9, 2018.

"Three small scratch marks were evident on the right-side door of the helicopter," the NTSB found. "Swabs of the scratched area were examined for organic residue, none was found. In discussion with the tour operator and local law enforcement, it was recognized that the Nu'alolo Kai hiking trail is very popular with drone operators and drones are often seen in the area."

The first confirmed midair collision of a drone and manned aircraft happened on Sept. 21, 2017, involving a DJI Phantom quadcopter that crashed into a U.S. Army UH-60M Black Hawk flying over New York harbor. The most recent collision occurred on Feb. 6, when a DJI Mavic 2 quadcopter struck an Airbus AS350BA helicopter while both aircraft were involved in the filming of an off-road truck race near Johnson Valley, California.

A third confirmed collision "was more comical than anything else," English said. On Aug. 10, 2018, a DJI Mavic Pro quadcopter being flown inappropriately within 5 mi. of an airport blundered into a Lindstrand 105A hot-air balloon carrying sightseers near Driggs-Reed Memorial Airport in Driggs, Idaho. The balloon was not damaged; the drone crashed to the ground.

"This was an amateur drone pilot operating next to an airport, next to other aircraft. The list of things that he really didn't understand was quite long," English said.

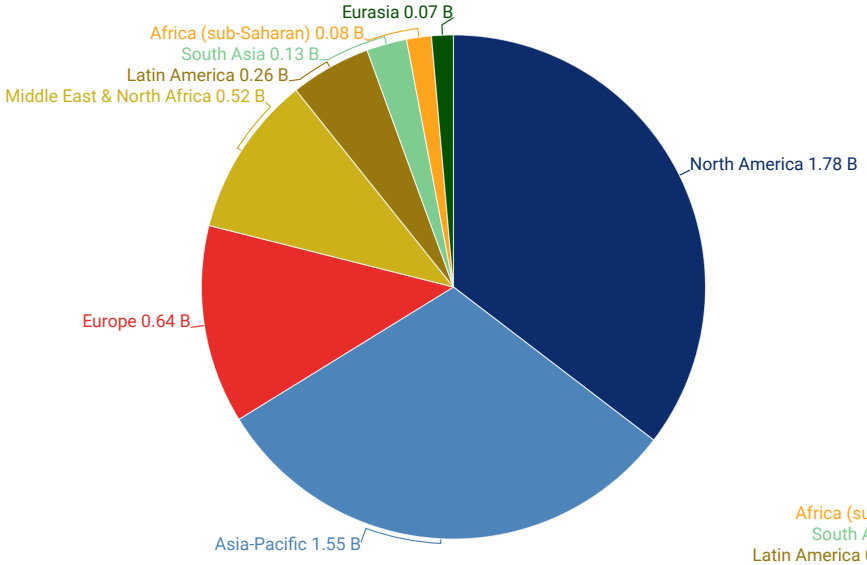
Aviation Week Forecasts

Trainer & Light Combat Aircraft MRO By Region 2020-2029

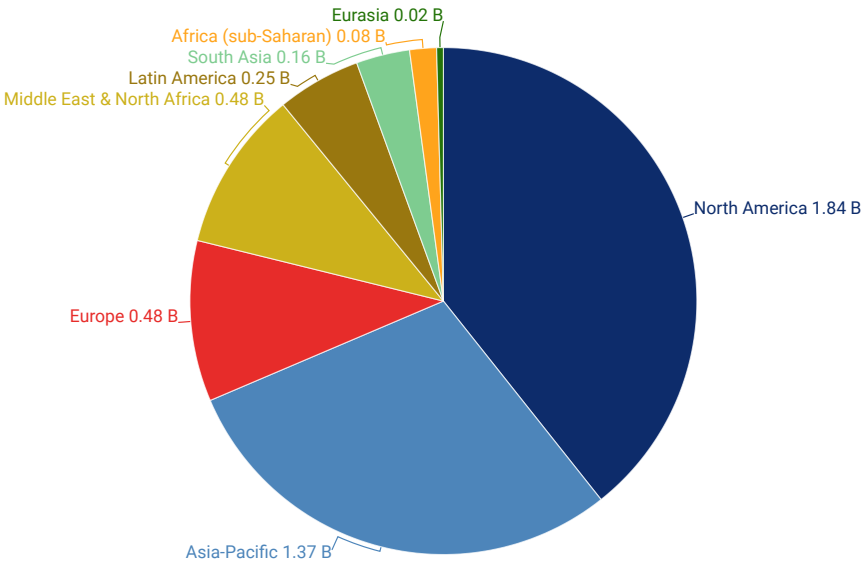
AVIATION WEEK NETWORK forecasts that the world's fleet of western-designed trainer and light combat aircraft (LCA) will generate $48.9 billion in maintenance, repair and overhaul (MRO) demand over the next decade. This fleet category encompasses a broad swath of aircraft, everything from piston-powered introductory trainers to sophisticated jet trainers and light fighters.

Global MRO demand will decrease for Trainer and LCA fleets over the next decade, with annual demand falling from $5 billion in 2020 to $4.7 billion in 2029. Much of this decline is driven by retirements of aging Northrop F-5 fleets in the Republic of Korea (99 remaining in service) being replaced by the KF-X, in Brazil (48) by the Saab JAS 39 Gripen, and in Switzerland (26) by an as-yet-unselected fighter.

Despite the global decrease, MRO demand for trainer and LCA will grow in North America and South Asia over the next decade. North American MRO demand will grow by 3.4% and South Asian demand by 23.1%. The increase in North America can be attributed mainly to the Armed Overwatch program in the U.S., under which 75 new LCA will be acquired for U.S. Special Operations Command. South Asia's increase comes primarily from India's planned acquisition of a new intermediate flight trainer as well as the continued development of their indigenous LCA, the Tejas.



Western Trainer & LCA MRO By Region: 2020



Western Trainer & LCA MRO By Region: 2029

Source: Aviation Week Intelligence Network (AWIN) 2020 Military Fleet & MRO Forecast
For more information about the 2020 Forecast and other Aviation Week data products, please see: http://pages.aviationweek.com/Forecasts
Prepared by Samuel Archer