

Why T-X Losers
Are Not Quitting

UK to EASA
'Cheerio'

How NASA Is
Cutting Red Tape

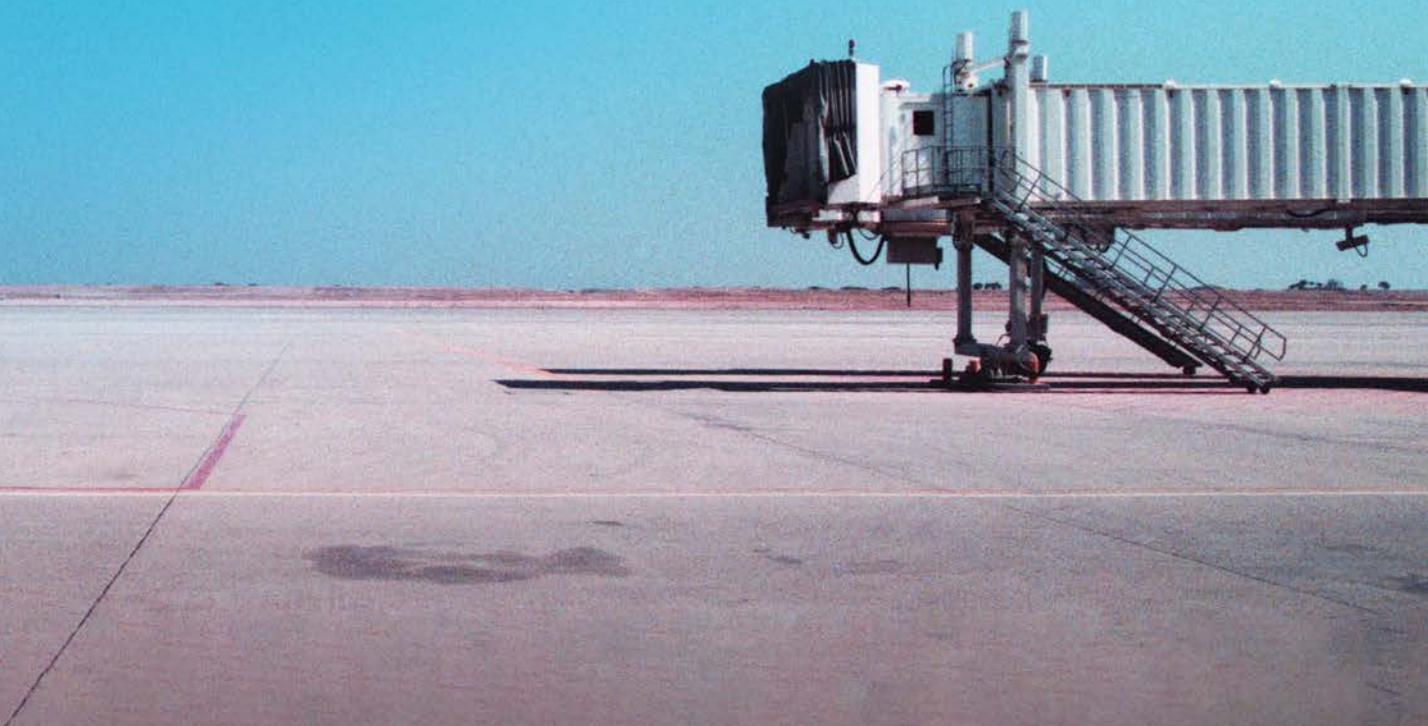
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ON THE COVER

Air transport ground to a halt in many parts of the world as the COVID-19 pandemic tightened its grip on Europe and North America. Starting on page 16, Aviation Week's global team of reporters provides an in-depth look at the biggest crisis ever to hit the commercial air transport industry—and how aircraft manufacturers and their suppliers are bracing for financial carnage in the coming months. Photo by John Lund/Getty Images

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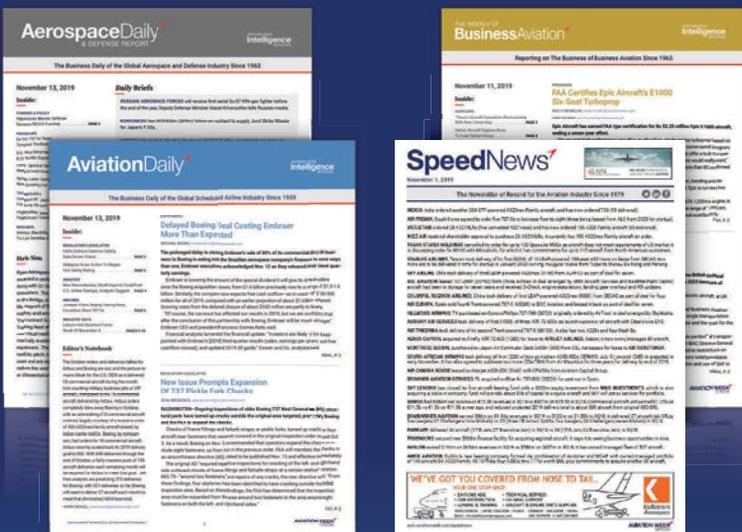
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WHICH ENGLISH?

Elizabeth Mathews is right in her analysis (*March 9-22, p. 12*), but which English language are we talking about?

I remember an *AW&ST* paper titled “Translating English into English” at the time the U.S. bought British AV-8B Harriers.

Andre Fournerat, Charenton-le-Pont, France



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LOCAL LANGUAGES

As an ICAO English language proficiency rater and head of training, I could not agree more with Elizabeth Mathews’ comments on English language testing requirements and especially with regard to required training for aviation professionals (*March 9-22, p. 12*).

However, one of the biggest threats to airline pilots operating in a global environment is the persistent use of local language by controllers and pilots alike. Fly into Madrid or Paris any day, and 50% of the crucial air traffic control communication is conducted in Spanish or in French.

As long as we tolerate this arrogance, all our other efforts will bear little fruit.

Helmut Kunz, Ratingen, Germany

‘TOUGH OLD BIRD’

As a follow-up to Lee Guthrie’s sister’s recall of the “beautiful Convair 880” (*March 9-22, p. 6*), I should add that, from personal experience, the 880 was a “tough old bird.” As vice president of technical services for TWA in the 1970s, I was responsible for the mechanical performance of its fleet, which then included 24 880s acquired by its former owner, Howard Hughes, who established its specifications with Convair.

When those gas-guzzling airplanes were grounded by the fuel prices following the 1973-74 oil embargo, I inherited responsibility for the parting-out of

these unsalable aircraft, although one of Howard Hughes’ former girlfriends did make an offer.

The 880, however, proved its toughness when the machines the contractor had used successfully some years earlier to chop up then-retiring Constellations failed to do serious damage to the 880s. Incidentally, Elvis’ 880 was acquired by Delta Air Lines through its purchase of Northeast Airlines, also owned by Hughes.

As an aside, the CJ805 that powered the 880, in addition to being fuel-hungry, was almost certainly the most unreliable engine ever produced by GE. Yet it may have been the source of that company’s later success because, in spite of the engine’s troubles, the company’s customer service in dealing with them effectively paved the way for industry acceptance later.

Robin H. H. Wilson, Seattle

MANUAL PROFICIENCY

I applaud the recent move toward including simulator training as part of the Boeing 737 MAX return to service reported in “Boeing MAX Simulator Training Is Taking Shape” (*Feb. 27-March 8, p. 20*). As a former airline captain and line check airman, I observed an increasing tendency by pilots to defer to automation and a reluctance to fly the aircraft manually. This is a very disturbing trend.

While aircraft manufacturers continue to move toward automation (to one day incorporate artificial intelligence) to prevent flight outside the aircraft envelope, these “fixes” are years away. And when, despite the designer’s best efforts, automation fails, pilots must still be proficient at taking over manually and putting the aircraft in a stable attitude, troubleshooting the issue and returning the aircraft to a safe landing.

In the case of both 737 MAX crashes, the original “abnormal” had nothing to do with the Maneuvering Characteristics Augmentation System (MCAS). The original malfunction was the angle of attack/stall warning system, which also affected one of the pilots’ airspeed and altimeter indications.

If each of these crews had maintained configuration, climbed to a safe maneuvering altitude and leveled off, the MCAS would never have come into play. Public reports to date indicate neither crew ever reduced power from takeoff thrust. This allowed the aircraft to eventually accelerate to Vmco and beyond, making manual trim inputs impossible due to air loads.

The above crashes are not the only ones where lack of the flight crew’s ability to manually fly the aircraft was a factor. Asian Airlines 214, Air France 447 and Atlas Air 3591 are just three additional examples where airline flight crews unsuccessfully attempted to manually fly the aircraft.

My suggestions are to first strongly recommend that when one mode (autopilot) is disconnected, the other automation mode (auto-throttle) also be disconnected. This leaves no doubt that the pilot is controlling both modes. My second suggestion is that recurrent training include some time spent at both high and low altitudes in manual flight.

All pilots should have confidence that when necessary they can manually control the aircraft in all phases of flight.

David A Vecchi, Park City, Utah

PUMP PRESSURE

The article “Refueling Revisited” (*Feb. 27-March 8, p. 42*) states: “The Air Force uses a boom that can pump up to 880 gal. per minute while the drogue system can pump 220-290 gal. at the same rate.”

Gallons per minute is a rate type measurement. I believe it should state “at the same pressure.”

Kerry Moore, Round Rock, Texas

CLARIFICATION

“Once-Abandoned Light-Attack Acquisition Revived, Again” (*Feb. 27-March 8, p. 50*) should have stated that other aircraft besides the Iomax are in contention for Mission Set 2.

Address letters to the Editor-in-Chief, *Aviation Week & Space Technology*, 2121 K Street, NW, Suite 210, Washington, DC, 20037 or send via email to: awstletters@aviationweek.com Letters may be edited for length and clarity; a verifiable address and daytime telephone number are required.

WHO'S WHERE

Tiphaine Louradour has been hired as International Launch Services president. Louradour had been president of global commercial sales at *United Launch Alliance*.



BAE Systems has promoted **Tom Arseneault** to president and chief executive officer from president and chief operating officer. He succeeds **Jerry DeMuro**, who moves to BAE executive vice president of strategic initiatives and will serve on the U.S. board.



Airbus has appointed **Richard Franklin** as managing director of *Airbus Defence and Space* in the UK. He succeeds Colin Paynter, who is retiring. Franklin will continue

to lead the secure communications business line, which includes the UK Defense Ministry's *Skynet 5* secure military satellite communications

The National Air Transportation Association has promoted **Timothy R. Obitts** to president and CEO from chief operating officer. He succeeds **Gary Dempsey**, who has stepped down.

SunExpress has named **Max Kownatzki** as CEO, subject to board approval. He succeeds **Jens Bischof**, who will become CEO of *Eurowings*. Kownatzki was a senior vice president at Lufthansa Group's *Hub Airlines*.



Northrop Grumman has elected **David F. Keffer** corporate vice president and chief financial officer. Keffer succeeds **Kenneth Bedingfield**, who has left the company. Keffer was a *Blue Delta Capital* partner and before that chief financial officer at *CSRA* and *SRA International*.



HawkEye 360 has hired **Dennis Burnett** as executive vice president and general counsel of the formation-flying satellite, data collection and analytics company. Burnett was consulting principal at *LMI Advisors*, chief counsel of regulatory and government

affairs at *Kymeta Corp.* and vice president of trade policy and export control for *EADS North America*.



Bollre Logistics has promoted **Yves Laforgue** to CEO of the Americas region from Asia-Pacific chief operating officer. He succeeds **Tony Rodrigues**.

Killick Aerospace Group has hired **Bill Molloy** as chief operating officer, a new position. Molloy held various leadership positions in both the commercial and business aircraft divisions at *Bombardier Aerospace*.

CACI International has named **Daniel Walsh** senior vice president and corporate strategic advisor for its national defense and homeland security business. He was White House deputy chief of staff for operations, director and deputy director of the White House military office, a military aide to former Presidents George W. Bush and Barack Obama and an instructor pilot/aircraft commander for military fixed-wing aircraft.

ePropelled has named **Gary Cardone** vice president and head of the electro-magnetic motor company's engineering and product development team. He was director of technology and director and vice president of product development.

Aerion Supersonic has hired **Matthew Mejia** as chief financial officer and executive vice president of strategy and investor relations. Mejia has held leadership positions with the aerospace practices at *Booz & Co.* and *Charles River Associates*, among others.

AAR has named **Jessica A. Garascia** as general counsel. Garascia was *USG Corp.* deputy general counsel, overseeing all mergers and acquisitions, compliance, corporate governance and securities law.



The Aerospace Corp. has appointed **Victor Ward** as general manager of

corporate planning and financial strategy. Ward was global head of finance at *BCG Digital Ventures* and group-level chief financial officer for *Computer Science Corp.* He began his career at *Lockheed Martin*.

Pentastar Aviation has hired **Brent Hanson** as account manager and client relations representative. Hanson was regional sales director for *Textron Aviation*.

Lockheed Martin has elected U.S. Marine Corps Gen. (ret.) **Joseph F. Dunford, Jr.** to its board. He will serve on the classified business and security and nominating and corporate governance committees. He is a former chairman of the Joint Chiefs of Staff.

2Excel Aviation has named Stuart Stanyard, former *Rolls-Royce* finance director, to its board.

VOX Space, a launch services provider for the national security community, has named U.S. Air Force Maj. Gen. (ret.) **Susan Mashiko** to its



board. Her career has spanned a variety of space and acquisition assignments, including as chief of the Programs Division in the Office of Special Projects and director of the Evolved Expendable Launch Vehicle Program.

General Dynamics has elected **John G. Stratton** to its board. Stratton was executive vice president and president of global operations at *Verizon* and held various leadership positions at *Bell Atlantic Mobile*, its predecessor.

Mercury Systems has appointed **Orlando P. Carvalho**, former executive vice president of *Lockheed Martin* aeronautics, to its board.

The Massachusetts Institute of Technology has named **Greg Olson** the Thermo-Calc Professor of the Practice in the Materials Science and Engineering Department. Olson co-founded metal-alloys developer *QuesTek Innovations* and was a tenured professor of materials science and engineering at *Northwestern University*. ☺

To submit information for the Who's Where column, send Word or attached text files (no PDFs) and photos to: whoswhere@aviationweek.com For additional information on companies and individuals listed in this column, please refer to the Aviation Week Intelligence Network at AviationWeek.com/awin For information on ordering, telephone U.S.: +1 (866) 857-0148 or +1 (515) 237-3682 outside the U.S.

FIRST TAKE

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DEFENSE

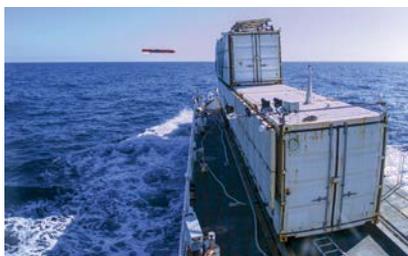
The U.S. Army has awarded Bell and a Sikorsky-Boeing team two-year competitive-demonstration and risk-reduction contracts for the Future Long-Range Assault Aircraft to replace the UH-60 Black Hawk (page 43).

The U.S. Air Force has finalized a deal with Textron Aviation for two AT-6 Wolverines to join two Sierra Nevada/Embraer A-29 Super Tucanos already ordered by Air Force Special Operations Command.

Mitsubishi Electric will supply four air-defense radars to the Philippines, in Japan's most significant arms sale since it lifted a self-imposed ban on exporting military equipment in 2014.

The U.S. Air Force is scrambling to acquire Gulfstream G550s to complete the EC-37B Compass Call rehost program ahead of a possible production shutdown, despite no official change in the company's outlook for the jet.

DGAEMT/ARMIES



European missile manufacturer MBDA has completed the first qualification firing of its Anglo-French Sea Venom/Anti-Navire Leger anti-ship missile from an AS365 Dauphin helicopter.

COMMERCIAL AVIATION

Boeing is to modify wiring in undelivered 737 MAXs before handing them over to customers, but is still working with the FAA and operators on how to manage grounded aircraft in customers' fleets.

Mitsubishi Aircraft on March 18 flew the first SpaceJet prototype conforming to the revised, certifiable design of the regional jet. Certification of the initial M90 version has slipped to 2021.



LONGVIEW AIRCRAFT SERVICES

Canada's Longview Aviation Services flew the initial CL-215 amphibian upgraded to a CL-415EAF Enhanced Aerial Firefighter on March 10, the first of six ordered by Bridger Aerospace of Montana.

French startup VoltAero has begun flight testing its Cassio 1 hybrid-electric regional-aircraft testbed equipped with two 45-kW motors supplied by Safran Electrical & Power.

Irelandia Aviation, which is behind five different low-cost carriers around the

world, has invested in Skyports, a UK developer of infrastructure for passenger and cargo urban air mobility.

Chinese electric vertical-takeoff-and-landing (eVTOL) developer has signed an agreement with the city of Seville to launch its first urban air mobility pilot program in Spain.

COVID-19 IMPACTS

Facing coronavirus-related travel restrictions, airline capacity cuts are reaching 90%, more than 40 carriers have stopped flying altogether, and the number keeps rising. Multiple bankruptcies are expected before the industry recovers (page 16).

Arianespace on March 16 suspended its launch preparation activities at Europe's spaceport in Kourou, French Guiana, as a precaution.

NASA on March 17 ordered all employees to work at home, with only mission-critical personnel being allowed on sites throughout the U.S.

Airbus paused production at its French and Spanish facilities for four days, starting March 17, to implement new health and safety measures.

VIEW FROM WASHINGTON

NASA Keeps Eyes Fixed on Return to Orbit

The COVID-19 pandemic may have caused NASA to shutter its centers, but the agency is working with SpaceX toward a mid-to-late-May launch of astronauts Bob Behnken and Doug Hurley on the first manned Crew Dragon flight to the International Space Station (ISS).

Behnken and Hurley, both veterans of two space shuttle missions, will comprise the first crew to fly aboard a U.S. orbital spaceship since the shuttle Atlantis completed the 135th and final flight of the program in July 2011. Hurley was the pilot on that mission.

Their return to orbit will be to test SpaceX's Dragon 2 spacecraft following the company's successful Demo-1 uncrewed trial run to the ISS in March 2019. A firm launch date for the crewed flight test, Demo-2, has not been set, but NASA on March 18 issued a press advisory targeting a mid-to-late May timeframe.

Behnken and Hurley, colonels in the U.S. Air Force and U.S. Marine Corps, respectively, have been training for a possible extended stay on the ISS, which is currently understaffed.

Hurley's commander on the final shuttle mission, retired NASA astronaut Chris Ferguson, joined Boeing in 2011 and is in training, along with NASA astronauts Nicole Aunapu Mann and Michael Fincke, for a crewed flight aboard Boeing's CST-100 Starliner, possibly later this year.

On March 18, a French Air Force Airbus A330 tanker/transport equipped with the Morphee intensive-care module began transferring COVID-19 patients from overloaded hospitals.

Textron Aviation plans to begin four-week furloughs for most of its 7,000 U.S. employees on March 23 and will adjust Cessna and Beechcraft production rates to anticipated lower demand.

Airbus UK and Rolls-Royce are among companies that responded to a UK government call for the rapid production of medical ventilators to treat people with the coronavirus.

SPACE

The European Space Agency and Russia's Roscosmos have postponed their joint ExoMars 2020 mission to 2022, as testing could not be completed before this summer's launch window.

No reason has been given for the March 16 failure of the first flight of the second version of China's Long March 7 medium-heavy spacecraft from Wenchang on Hainan.

SpaceX's 20th and final Dragon 1 capsule reached the International Space Station early March 9 to deliver a 4,300-lb. cargo, including crew supplies and science and technology payloads.

Smallsat launch company Rocket Lab has reached a deal to acquire Toronto-based satellite hardware supplier Sinclair Interplanetary.

The first Orion spacecraft, scheduled for an unmanned mission as part of NASA's Artemis lunar program, has passed key space environment tests.



Bryan Perkins (center), Ann Speed and Joanna Speed (far left), Greg Hamilton and Joe Anselmo (far right).

AWARDED

At the 34th Annual SpeedNews Commercial Aviation Industry Suppliers Conference in Los Angeles on March 10, the Aviation Week Network presented the Sixth Annual Gilbert W. Speed Award to Bryan Perkins, CEO and cofounder of Novaria Group. He received the award from Ann Speed, Managing Director for A&D Events; Joanna Speed, Aviation Week Network President; Greg Hamilton and *AW&ST* Editor-in-Chief Joe Anselmo.



NASA

OBITUARY

Alfred "Al" Worden, command module pilot on the Apollo 15 mission to the Moon, died March 18 in Texas. He was 88. Worden was a U.S. Air Force test pilot before being selected by NASA as an astronaut in 1966. On Aug. 5, 1971, on the return trip from the Moon, Worden became the first person to carry out a deep-space spacewalk, describing it as an "unbelievable place to be." He became a senior aerospace scientist and later chief of the Systems Study Division at the NASA Ames Research Center. After retiring from NASA and the Air Force in 1975, Worden became an aerospace industry executive.

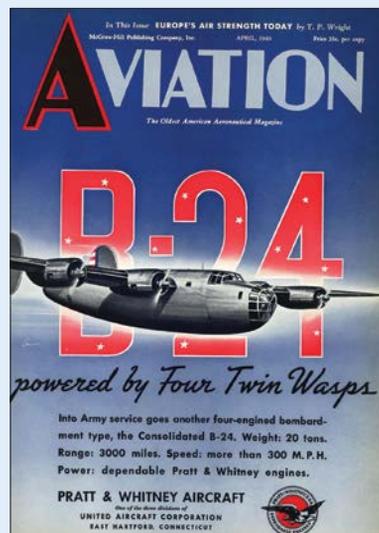
PROMOTED

Lockheed Martin has tapped an aerospace veteran to lead the Pentagon's largest contractor starting June 15. Board member Jim Taiclet was named to also be CEO and president. Current chief executive Marilyn Hewson will become executive chairman (page 34).

Alain Bellemare is stepping down as president and CEO of Bombardier, having overseen a radical restructuring of the Canadian company. He will be succeeded by Eric Martel, current president and CEO of Hydro-Quebec and a former Bombardier executive. ☪

80 YEARS AGO IN AVIATION WEEK

The new B-24 bomber graced the cover of our April 1, 1940, edition as part of an advertisement for Pratt & Whitney, which supplied the aircraft's four Twin Wasp engines. Developed by Consolidated Aircraft of San Diego, the B-24 was conceived as a faster, longer-range cousin to the B-17, designed to fly up to 290 mph and carry a 5,000-lb. (2,268-kg.) bomb for 1,700 mi. Dubbed the "Liberator," the B-24 was mass-produced during World War II and deployed by the U.S. and UK to every theater, bombing Axis targets, protecting maritime convoys, scouting and destroying U-boats and softening German defenses during the D-Day invasion of France. A total of 18,482 B-24s were built before production ended in 1945, making it the most produced bomber of all time.



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UP FRONT

KEVIN MICHAELS

**THE RECENT PASSING OF FORMER**

GE CEO Jack Welch may represent more than the loss of the icon named Manager of the Century by *Fortune* magazine in

1999. It may also symbolize the passing of an era in capitalism—"shareholders first"—that Welch did so much to promulgate. What does this have to do with today's aerospace industry? Plenty, as it turns out.

Before the "shareholders first" mantra took hold in the 1990s, publicly traded companies considered four stakeholders in allocating capital: customers, local communities, employees and suppliers, and shareholders.

Rethinking 'Shareholders First'

Our long-cycle, innovation-driven industry is out of balance

Before Welch took over in 1981, GE publicly stated it valued workers and research labs before shareholders. After 20 years of relentless focus on productivity, cost-cutting and shedding more than 100,000 jobs, GE's market capitalization skyrocketed from \$12 billion to an astounding \$410 billion. Much of this profit growth was driven by financial services rather than traditional manufacturing.

Encouraged by the late economist Milton Friedman and success stories such as GE, aerospace executives began to adopt "shareholders first" in the 1990s. McDonnell Douglas famously embraced this philosophy and focused on quarterly earnings while refusing to invest in new civil aircraft. Its CEO, Harry Stonecipher, eventually took the leadership helm at Boeing. Responding to the perception that he was only interested in making money, he responded, "You're right, I am."

Employees were the first casualty, with unions weakened and raises curtailed. For example, until recently, Honeywell International imposed mandatory unpaid leave on its employees—while it was making 20% margins. As employees lost pace, so did local communities. In the early 2000s, the number of employees in low-wage countries became a key performance indicator. New aerospace clusters in places such as China, Eastern Europe and Mexico followed suit. The blind push to leverage labor-arbitrage has ebbed in recent years, but the compact of secure employment was violated, and employee morale suffered.

A decade later, suppliers became the target of OEM supply chain cost-reduction initiatives with double-digit price reduction demands, longer payment terms, aftermarket royalty payments and other concessions. Market capitalization shifted from suppliers to the

OEMs, while the lower tiers of the supply chain were bled of working capital. Today, many subtler suppliers are fragile, and their ability to invest in the future—let alone ride out a crisis like the 737 MAX production shutdown—is diminished compared to a decade ago.

What about customers? On the one hand, brutal competition between Airbus and Boeing held jetliner prices relatively flat over the past 15 years. On the other hand, customer satisfaction in the aftermarket and customer support is suffering. In last year's AeroDynamic Advisory/Aviation Week Network customer satisfaction survey, just one out of 41 OEMs received a positive net promoter score from airlines.

The manifestation of the "shareholders first" philosophy is very negative for a long-cycle industry like aerospace, which faces enormous challenges—including sustainable development—that will require large sums of R&D. Boeing, for example, spent an average of \$12.8 billion in share buybacks and dividends in 2018 and 2019, while averaging just \$2.2 billion in R&D. This is not just a Boeing problem; it is a corporate America problem. In 2018, share buybacks and dividends for the S&P 500 were an astounding 109% of net income, according to *The Wall Street Journal*. This disparity points to another issue: Companies are taking on debt to fund shareholder generosity. This is not sustainable in the long run and leaves no capital to invest in customers, suppliers, employees or local communities.

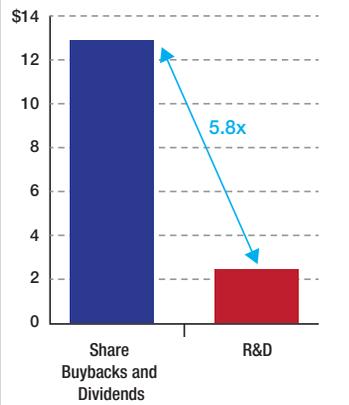
Contrast this behavior with OEM customer Delta Air Lines, which earned \$6.5 billion in 2019. It shared \$1.6 billion (16.7%) of that with employees—a record amount for a U.S. company. This translates into improved employee morale and in turn improved customer satisfaction, higher yields and growing market share.

Don't get me wrong. I am a pro-business, free-trade capitalist who depends on increasing stock prices to fund his retirement. Making money and rewarding shareholders is a good thing. However, our long-cycle, innovation-driven industry is clearly out of balance.

"Shareholders first" needs to be replaced by a more balanced version of capitalism if the aerospace industry is to thrive in the long run. The change must originate not only from aerospace leaders, including the new CEOs of Airbus and Boeing, but also from the boards that evaluate them and set priorities. ☺

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Contributing columnist Kevin Michaels is managing director of AeroDynamic Advisory in Ann Arbor, Michigan.

Average Annual Boeing Expenditures, 2017-18
(U.S. \$ Billion)



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GOING CONCERNS MICHAEL BRUNO

THE COVID-19 OUTBREAK IS THE biggest punch to the gut commercial aviation has taken since the Sept. 11, 2001, terrorist attacks. And coming on the heels of the Boeing 737 MAX crisis, Airbus and Boeing widebody production rate cuts, U.S. trade wars and the flight-shaming movement in Europe, the coronavirus emergency is challenging the aerospace manufacturing sector and its global supply chain.

Is the historic upcycle of commercial aircraft orders over? Will orders be canceled and deferred? Will business aviation go out of favor? Only time will tell, but it has been interesting to hear what aerospace and defense (A&D) executives are worrying about.

First, lost revenue from disrupted operations in China is not among their worries. Practically no one in A&D manufacturing has revised their 2020 financial forecasts—provided in January or February—because of COVID-19 alone.

“To date, we have no reported cases of our employees having contracted the virus, and the direct impact to our trading activities has been minimal,” Senior Plc CEO David Squires said March 2.

Likewise, GE CEO Larry Culp did not change the company’s financial outlook because COVID-19 was already cited in a forecast given last month. “In our view, in all likelihood it is going to be temporary, but it doesn’t mean it is going to disappear tomorrow,” Culp said at a March 4 shareholder briefing.

To be sure, some OEMs and suppliers with Chinese operations had to shut down in recent weeks due to COVID-19. But those factories are back up, and the impact to revenue was limited. For instance, only 20 of Triumph Group’s roughly 5,000 active suppliers are located in China or South Korea. All 20 remain operational, and no supply chain interruptions have occurred.

On the supply side, the glancing blow could have a lot to do with the fact that not much in Western aerospace is sourced in China. According to U.S. Commerce Department data, the U.S. imports just \$1.1 billion annually in aircraft, spacecraft and related parts. What is more, that figure has been dropping since 2016—before the U.S.-China trade war—and was expected to fall off a cliff for 2019 and 2020 regardless of the “Phase One” trade deal truce.

China always was a twofold market for U.S. aerospace: Sell parts and services to existing Western-supplied

fleets there, and partner for local production of nonproprietary parts and systems for emerging Chinese fleets. But China is ramping up efforts to get its own fleet into operation and is pairing with Russian suppliers more often. Any growth in overall aerospace trade likely would have to come from a jump in Chinese orders of Airbus or Boeing airliners, which was not widely expected in the wake of the Jan. 16 trade truce and is not anticipated now after the recent plummet in Chinese air traffic.

Although collapsing demand worldwide for air travel could have a devastating effect on A&D manufacturing

and supply, executives do not consider it likely. COVID-19 quickly turned into a short, sharp shock to the system, but industry leaders see the same underlying macro conditions driving long-term growth. Chief among them: expanding middle classes worldwide that spend more discretionary funds traveling by air for leisure.

During the 2020 Aviation Summit in Washington, new Collins Aerospace President Stephen Timm was asked if the airliner-customer landscape could look a lot different in coming years due to the scare.

“Frankly, we’re going to see differences,” Timm said. “This will be a blip—a serious blip that we have to deal with today—but compared with the macro aerospace industry, we’re in a really good place.”

Where do industry insiders see change coming to the supply chain? For one thing, COVID-19 could help deepen resistance to business travel, said some attending Aviation Week’s Annual Aerospace Raw Materials and Manufacturers Supply Chain Conference on March 9-12. That would exacerbate the ongoing drop in demand for widebodies.

Still, the biggest change could come in accelerating a budding shift in A&D supply from globalization to regionalization. Executives and consultants at both the Wharton Aerospace Conference on Feb. 29 and Aviation Week’s supply chain event discussed how COVID-19 cements a belief that just-in-time global supply chains are too risky and not worth the lower cost anymore.

Instead, they look to capitalize on aerospace manufacturing hubs in Asia, Europe-North Africa and North America to supply themselves. The trend could start with aerostructures for future single-aisle airliners, especially as composite materials are increasingly incorporated. “From a colocation strategy,” says one supplier executive, “you will see it in the next-gen airplanes.”

Sharp Shock

How the **coronavirus crisis** is likely to alter the **aerospace supply chain**



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GRAHAM WARWICK

COMMERCIAL SPACE'S FAST PACE

and the risks it is taking on are illustrated by DARPA's Launch Challenge, which ended on March 2 without the \$12 million in prize money being claimed.

Initiated in April 2018, the challenge was intended to demonstrate a flexible and responsive "anywhere, anytime" capability to launch small satellites to low Earth orbit (LEO) on demand. It was purpose-designed to harness commercial industry's efforts to dramatically reduce the cost and time to launch.

Competitors would be given weeks, not years, notice of the launch site, payload and orbit, and just days to set up and launch. A successful flight to LEO would win \$2 million and a chance to secure the \$10 million grand prize by launching a second time, just weeks later, from a different site, to a different orbit with a different payload.

Dozens of companies registered, 18 prequalified and, in April 2019, the DARPA named three finalists: Vector Launch, Virgin Orbit subsidiary VOX Space and an unidentified startup in stealth mode. They covered both vertical and horizontal launch options, and DARPA identified four possible launch sites across the U.S.

But the commercial industry was evolving quickly. Vector withdrew from the challenge last September, citing financial issues. In December, with its small-satellite launcher still unflown, the startup filed for bankruptcy protection.

Formed to pursue the U.S. national-security market, VOX withdrew in October 2019 to allow parent Virgin Orbit to focus on the first commercial flights of its LauncherOne. The first test of the air-launched booster is imminent.

The surviving challenge competitor was revealed in February as Alameda, California-based Astra, founded by former NASA Chief Technology Officer Chris Kemp and Adam London, whose company, Ventions, formed the basis of the startup.

By the time Astra was revealed as the sole participant, the character of the challenge had changed. In 2018, DARPA not only had anticipated multiple competitors but also had expected them to complete several test launches before the challenge flights.

But delays at Astra meant the first launch under the challenge would be the first flight for its rocket. "Astra's first launch moved to this year, which made it

additionally challenging," says Todd Master, DARPA program manager.

The departure of VOX removed the need for horizontal launch sites, so DARPA reduced the choice of locations to two: Kodiak, Alaska, and Wallops Island, Virginia. "As we got closer to launch, we realized we would be holding open a bunch of ranges and launch dates," Master says.

Astra was given 72 days' notice that the first flight would be from the Pacific Spaceport Complex at Kodiak, but—instead of forcing it to pack up after launch and move across the country—DARPA decided the second flight would be from another pad 1,000 ft. away at Kodiak.

"We didn't want to make this a logistics challenge or a regulatory challenge," Master says. "Whether we moved 5,000 mi. or 1,000 ft., the technical challenges associated with it and the benefit of what we are trying to demonstrate remained the same."

Conducting both launches from Kodiak simplified the regulatory process, making it easier to meet requirements for flight safety analysis and closing airspace. "But

the team was still not sure until 30 days out what the final trajectory would be," he says.

The launch window established by DARPA opened on Feb. 17. Astra was able to transport its containerized launch vehicle to Kodiak, set up on a bare pad, integrate a DARPA-supplied payload, complete pre-flight procedures and attempt a launch.

But on March 2, 53 sec. from liftoff, Astra scrubbed the launch because of a sensor anomaly, and the window closed, ending the challenge without a single flight. "We set aggressive but achievable goals. Astra got close but did not achieve them," Master says.

While disappointed, Master praises Astra for taking on the challenge, which it says did achieve several of the goals set, including speeding up the regulatory processes required to approve a launch. Undeterred, DARPA is looking again at how to demonstrate that flexible and responsive space launch can be valuable in battle.

Astra's first rocket is called "1 of 3" because it expects it will take three launches to reach orbit. Its participation in the challenge was always high-risk. "We were 53 sec. from launch, and there was nothing at that site just days before," says London. "We knew it was a long shot, but we understand how strategic responsive launch is to the government." ❁



ASTRA

Hard Space

DARPA learns the risks of working with commercial space startups



THE LAUNCHPAD

IRENE KLOTZ

ELON MUSK WAS DREAMING BIG when he founded SpaceX in 2002 at the tender age of 30. He's the first to admit all the mistakes he has made in what may prove to be a quixotic quest to help humanity evolve into a multiplanet species. But what irks him the most is that 18 years later—and with age 50 clearly in sight—Musk is still waiting to fly people in space.

“It's great that we're about to launch people to orbit; it's been a long time—18 years. You could have [had] a kid and have sent him off to college by now,” Musk quipped during the Satellite 2020 keynote address in Washington on March 9.

Stepping Up the Pace

in 2020, he'd be like: ‘That's crazy.’ Yet, we are. We don't want to be in that situation.”

While the fruits of SpaceX's labor on the Crew Dragon program are at hand, Musk has turned his attention to the design and test of the Starship deep-space transport, a two-stage, fully reusable system for passengers and cargo. “Moving ahead in the human exploration of space depends completely on a fully and rapidly reusable rocket,” says Musk. “Without that, we're going nowhere.”

If building the behemoth Starship was not challenging enough, Musk simultaneously wants to ensure the system can be manufactured rapidly—one Starship every three days. SpaceX has reached a high production

Musk bemoans **the slowness** of human spaceflight innovation



SpaceX CEO Elon Musk, left, with NASA's Bob Behnken, one of two astronauts slated for a flight test on Dragon 2 this spring.

SpaceX and Boeing were selected in 2014 by NASA to develop and fly commercially owned and operated space taxis to the International Space Station (ISS), with first launch expected in 2017.

Following a successful docking of an uncrewed Dragon 2 capsule at the ISS in March 2019 and a demonstration of Dragon's inflight launch abort system in January 2020, SpaceX is preparing for a crewed flight to the ISS as early as May. The mission will be the first to launch astronauts into orbit from the United States since the end of the space shuttle program in 2011.

“The thing that concerns me most right now is that unless we improve our rate of innovation dramatically, then there is no chance of a base on the Moon or a city on Mars,” Musk says.

“We need to be very careful about getting stuck in a ‘low-Earth maximum,’” he says like what happened during the 1981-2011 space shuttle program or with Russia's Soyuz spacecraft, currently the only transportation system for station crew ferry flights.

“Why does Soyuz still fly? It was designed in the 1950s,” says Musk. “If you told [Soviet designer] Sergei Korolev and the other guys that we'd still be flying Soyuz

rate with its Starlink internet satellites, pumping out 6-7 spacecraft per day, but nothing close to that rate with its Falcon rocket fleet.

At one time, SpaceX planned to produce 40 or so Falcon core stages per year, says company President and Chief Operating Officer Gwynne Shotwell. But that rate of production became unnecessary once SpaceX finalized a booster design that is expected to fly 10 times with minimal refurbishment between launches. The company's fleet leader launched for an unprecedented fifth time on May 18.

Boosting Falcon first-stage manufacturing to 40 per year, however, would have helped the company learn more about improving production techniques, Shotwell adds. “Manufacturing is hard to do, and I think the U.S. has kind of lost the magic. We have a lot to learn from others.”

Musk wants a fleet of 1,000 Starships, but he is starting to feel the heavy hand of time. “If we don't improve our pace of progress, I'm definitely going to be dead before we go to Mars,” he says.

Which may explain Musk's latest mantra: “If the schedule is long, the design is wrong.” 🚀

GROUND STOP

- > AIR TRANSPORT HAS NEARLY HALTED IN MANY PARTS OF THE WORLD
- > AIRLINES PLAN FOR EXTENDED GROUNDING
- > IATA: INDUSTRY NEEDS \$200 BILLION FROM GOVERNMENTS

Jens Flottau Frankfurt, **Sean Broderick** and **Ben Goldstein** Washington, **Helen Massy-Beresford** Paris, **Adrian Schofield** Auckland and **Bradley Perrett** Beijing

Just over two years ago, American Airlines Chairman and CEO Doug Parker surveyed the U.S. airline landscape and saw an unstoppable industry. “I don’t think we’re ever going to lose money again,” he proclaimed. “We have an industry that’s going to be profitable in good and bad times.”

The bad times have arrived, as any airline executive in the world can attest. As COVID-19 spreads and an ever-increasing number of countries go into lockdown, global air transport is grinding to a halt. Travel restrictions abound, capacity cuts are reaching 90% of normal levels, and more than 40 airlines have stopped flying altogether, a number that is rising daily.

Numerous bankruptcies are expected before the airline industry moves into some kind of recovery mode. When that will happen is anyone’s guess, but the longer the devastating groundings continue, the less will be left of what had been a prospering industry globally.

The questions now: When will profitability return, and what will the in-

dustry look like when that happens? Who will be left, and who will be gone? Will demand for air travel return to previous levels, given the unprecedented shock the global economy is now experiencing? And will containment of the coronavirus be more successful than anticipated, ushering in a quicker-than-expected return to relative normalcy?

What is clear is that the industry that emerges from the crisis will need to reset its business model. Over the past five years, U.S. airlines spent 96% of their free cash flow on stock buybacks—which boost the share price—and dividends, leaving little cushion for bad times.

And those bad times could be worse than anyone imagined. As recently as December, the International Air Transport Association (IATA) expected the industry to turn a \$29 billion net profit in 2020. Three months later, IATA is forecasting a year-end loss of \$40 billion, similar to what was seen in the 2008-09 global financial meltdown. IATA Director General Alexandre de Juniac says the industry will require \$150-200 billion in government assistance to overcome liquidity shortfalls.

De Juniac believes one outcome of the crisis will be industry consolidation, as carriers are forced out of business or form larger airlines to survive. And aircraft manufacturers and sup-

A depressing sight at airports worldwide—empty gates waiting for aircraft.

pliers will feel the pinch in the coming months as the effects of deferred or canceled orders ripple through the industry (see page 21).

IATA Chief Economist Brian Pearce projects that the average airline has a little more than two months' worth of cash to cover fixed costs. "There is a growing liquidity crisis in air transport," he says. Countries affected by COVID-19 now represent 94% of the global air transport market, and new travel restrictions and border closures are being added daily. "Demand has fallen to zero," Pearce says.

And not all airlines are equal. Most airline profits during the past decade were generated by about 30 carriers at, or near, investment-grade ratings. Many others lost money even in good economic times.

A slump in fuel prices will provide some cushion and could save the industry up to \$30 billion annually. But airline revenue losses are far greater, and hedging—particularly popular in Europe—is delaying the positive effect.

So what is the other side of the COVID-19 crisis going to look like? It will likely include the return of high-yield demand but with fewer airlines—particularly outside North America, say analysts at JP Morgan.

Global business travel has been crippled by national travel bans, mass cancellations of conventions and other major events and a rapidly expanding push for people to isolate themselves as much as possible and work from home. But has the panic gone too far? Investment bank JP Morgan

dismisses speculation that demand for business travel will slump in the post-COVID-19 environment. "It was asked after 9/11, SARS, the full-size toiletry ban and the [2008-09 global financial crisis]," its analysts wrote in a March 16 note to investors. "Our advice is to ignore the topic."

Another area of rampant speculation: Which airlines will survive the crisis? JP Morgan sees far more risk outside North America, which accounts for about 20% of global capacity but 65% of airline profits. Last year "was already witness to a record number of airline failures despite a salubrious fundamental backdrop," the bank noted.

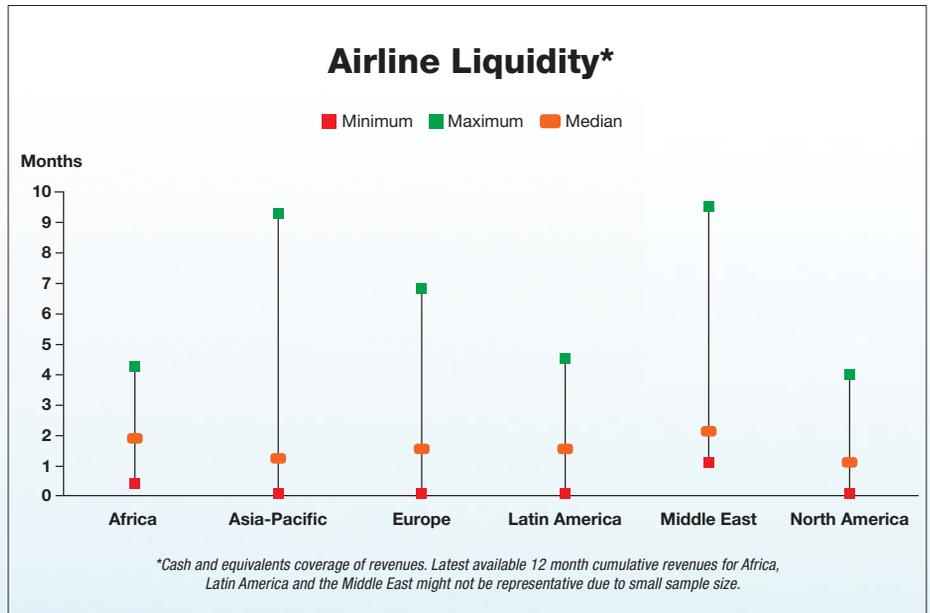
THE AMERICAS

In the U.S., JP Morgan sees consolidation coming before a major airline failure. "Downturns have spurred

domestic consolidation and this crisis may prove similar . . . though current fundamentals are gyrating with such momentum that achieving merger traction may prove difficult," the analysts wrote. "From a regulatory perspective, it's hard to imagine the government blocking even the largest of deals."

One wild card that will help determine what the post-COVID-19 industry looks like is government aid. Italy is nationalizing perennially struggling Alitalia, and carriers around the world are leaning on their governments for help. U.S. airlines also want big money, asking the federal government for a \$58 billion package of grants and loans and relief from all excise taxes through 2021. President Donald Trump has signaled support for the idea.

"We'll be backstopping the airlines

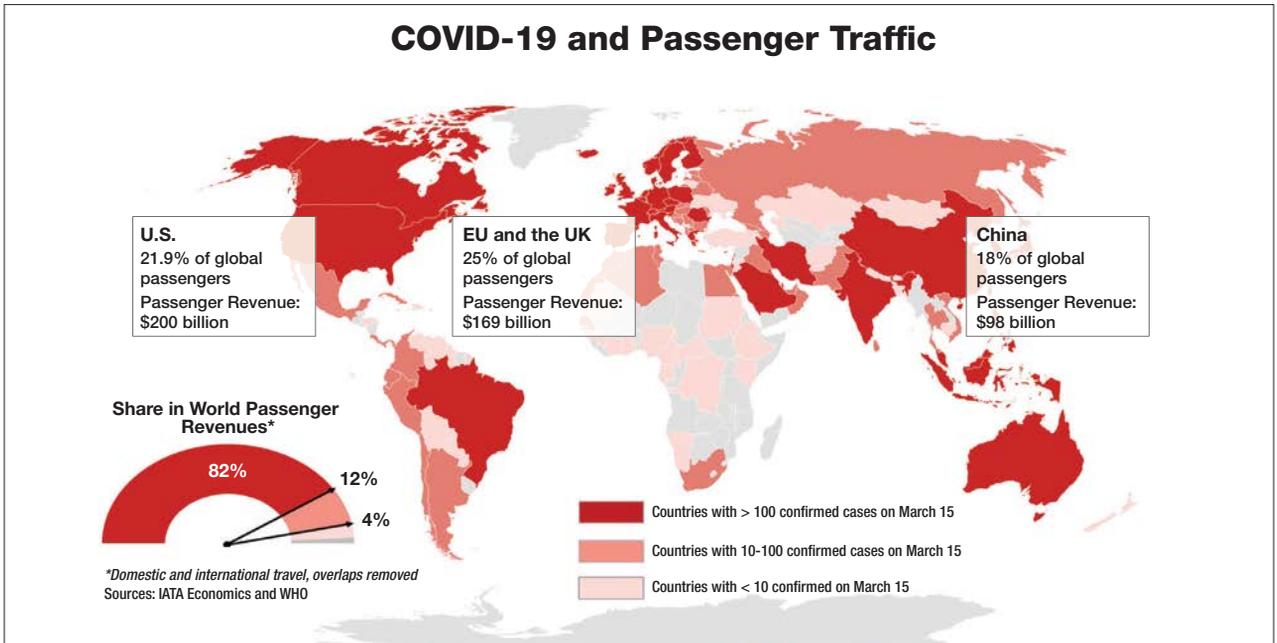


Source: IATA

JOHN LUND/GETTY IMAGES



COVID-19 and Passenger Traffic



Source: IATA

and helping them very much,” Trump told reporters at the White House briefing room hours after airlines proposed the bailout through their lobbying arm, Airlines for America (A4A). “We’re going to be in a position to help the airlines very much.”

The proposal, broken down by the Eno Center for Transportation, would provide U.S. airlines with \$29 billion in immediate grants—including \$4 billion for cargo carriers—\$29 billion in loans and loan guarantees and \$7-10 billion in excise tax forgiveness. That dwarfs the \$10 billion in loan guarantees the government made available after the Sept. 11, 2001, terrorist attacks. Of that, just \$1.2 billion was ever dispersed.

U.S. airports have asked for an additional \$10 billion in immediate grants to help offset the massive drop in travel levels due to the COVID-19 pandemic. The Airport Council International-North America estimates that U.S. airports will lose \$8.7 billion in 2020, a number a spokeswoman said is “likely to grow as the fundamentals continue to erode.” The group forecasts passenger traffic at U.S. commercial airports will drop by 68% in the March-June period.

The requests for government aid come on the heels of a two-week period that saw the position of U.S. carriers rapidly deteriorate following cascading worldwide travel bans, including a White House ban on travel

from Europe and the UK, over concerns about the spread of COVID-19.

The sharp downturn in demand has caused bookings to plummet, with some carriers reporting cancellations outpacing new bookings by more than a 2-to-1 ratio. “There is still significant uncertainty underlying assumptions, but today’s context is much worse than 9/11,” A4A said.

Virtually all U.S. carriers are slashing capacity, particularly on international routes. Delta Air Lines cut system-wide capacity by 70% and parked up to 600 aircraft across its mainline and regional fleets. United Airlines has reduced its April schedule by 60%, including a 42% reduction in North American flying and an 85% decrease in international service. And American Airlines reduced domestic schedules by 20% in April and 30% in May and suspended all but three international routes. Domestic-oriented carriers, including Alaska Airlines, JetBlue Airways, Southwest Airlines and Spirit Airlines, have all trimmed schedules 20-40%.

For some older, less-efficient aircraft, the groundings could be permanent. Cowen & Co. analyst Helene Becker expects a “significant portion” of the aircraft being parked will remain out of service after the crisis subsides. American Airlines, for example, has effectively retired its Boeing 767 fleet ahead of schedule, and has accelerated retirement of its

757 fleet. Executives at Delta likewise have signaled a willingness to retire the carrier’s last remaining MD-88s and MD-90s early, as well as some of its older 757s and 767s, as a result of the COVID-19 crisis.

Using financial data from its member airlines, A4A has modeled scenarios of airline liquidity levels through the end of the year absent government relief, depending on the accessibility of outside cash and capital markets.

Under the optimistic scenario, with ready access to financial markets, U.S. carriers would see net liquidity levels drop a combined 45% to \$18 billion through the first six months of the year, falling further to \$16 billion by year-end.

Under the pessimistic scenario, without sufficient sources of cash, A4A forecasts a 67% net drop in liquidity levels for passenger carriers by June, to \$12.8 billion, deepening to a deficit of-\$14 billion by year-end. As of March 16, “the pessimistic scenario is looking most likely,” the trade group said. Should the Trump administration enact a rumored 30-day domestic travel ban, the liquidity crisis facing U.S. airlines would be even more severe.

In Latin America, the largest commercial carriers have suspended nearly all international flying and slashed domestic capacity as the financial fallout from the COVID-19 cri-

sis reverberates. Chile-based LATAM Airlines Group—the continent’s largest by fleet size and passengers flown—plans to reduce system-wide capacity by 70%, including a 90% cut to international flying. Rio de Janeiro-based Gol curtailed its schedule by 60-70%. Sao Paulo-based Azul will reduce capacity by 35-50% in April. Bogota-based Avianca cut service 30-40%. And Panama’s Copa Airlines expects to reduce capacity more than 80% in April “without ruling out the possibility of a complete, temporary shutdown of its operations.”

EUROPE AND THE MIDDLE EAST

Most airlines in Europe are pulling back flying by at least 80%. Lufthansa has grounded three subsidiaries—Austrian Airlines, Brussels Airlines and Air Dolomiti—and will cut capacity by 95%. Norwegian and SAS Scandinavian Airlines are implementing temporary mass layoffs of most of their staff. Skeleton networks remain in place, mostly for repatriation flights. Lufthansa Group will operate

port” as airlines cull schedules amid demand declines of 60% that are continuing to rise. “The scale of the current industry crisis is much worse and far more widespread than 9/11, SARS or the 2008 global financial crisis,” IATA said.

The European Commission (EC) has sent member states a draft of proposed changes to state aid rules that would provide more flexibility to support companies hit by the pandemic, as airline groups called for more support in the short term, as well as for longer-term post-crisis recoveries.

EC Executive Vice President Margrethe Vestager said March 17 that the commission wanted to ensure businesses have the liquidity they need and that support for a business in one member state does not undermine European unity. “We have to be able to rely on the European single market, to help our economy weather the outbreak, and bounce back strongly afterward,” she said.

New temporary rules could include aid in the form of grants, guaranteed loans and subsidized interest rates

sion was ready to work with member states to minimize permanent layoffs and damage to the European aviation sector, by using the full flexibility of state aid rules to grant compensation to airlines under Article 107(2)(b) TFEU for damages suffered due to the COVID-19 outbreak, even if they have received rescue aid in the last 10 years. “In other words, the ‘one time last time’ principle does not apply.”

CHINA

Airlines in China, where the pandemic broke out but is now easing, have been restoring domestic capacity since the second half of February. They cautiously scheduled small increases in international services—before changing tack again in the second week of March as the outbreak exploded in Europe and North America. China Eastern Airlines will reduce or suspend flights on 11 European and North American routes.

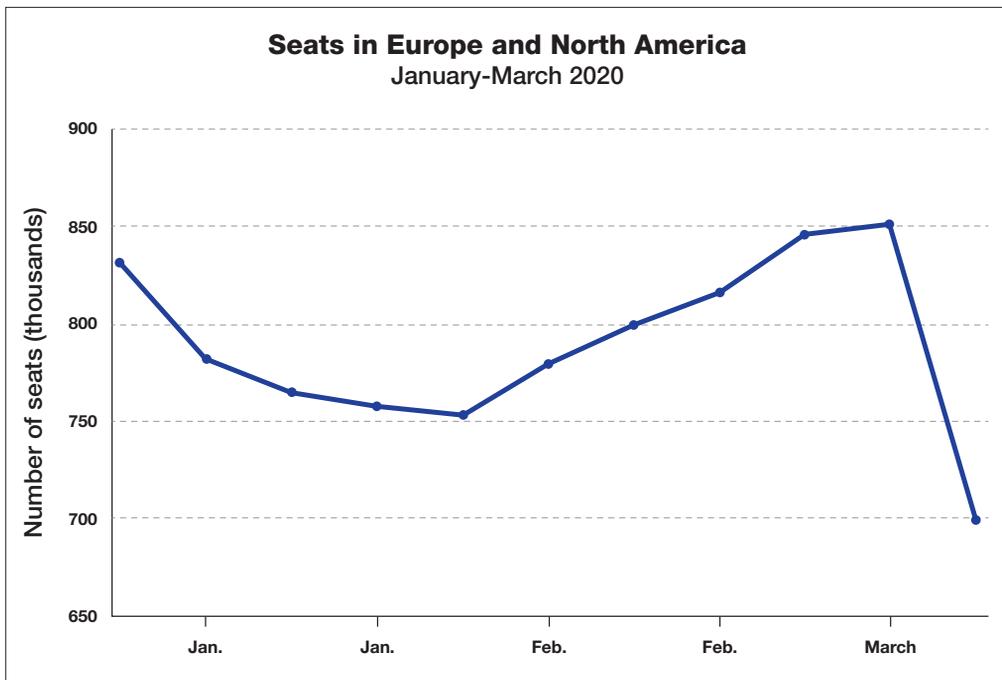
Chinese authorities are moving to forbid international flights from landing directly in Beijing. Instead, they

propose, aircraft will have to land in other cities in Northern China, where passengers will be given health checks. If no sign of the disease is found, the aircraft may proceed to Beijing. If anyone aboard is afflicted, the flight will go no farther and the danger to public health will be handled locally.

The policy was supposed to begin on March 18, but a day later had not been fully implemented, having met some resistance from intermediate cities and foreign airlines. It evidently addresses the rising problem of imported cases of COVID-19, a result of

the spread of the contagion outside of China and the scramble by the Chinese to return to their homeland, where the disease now appears to be well-controlled.

Keeping COVID-19 controlled in Beijing is particularly important to the



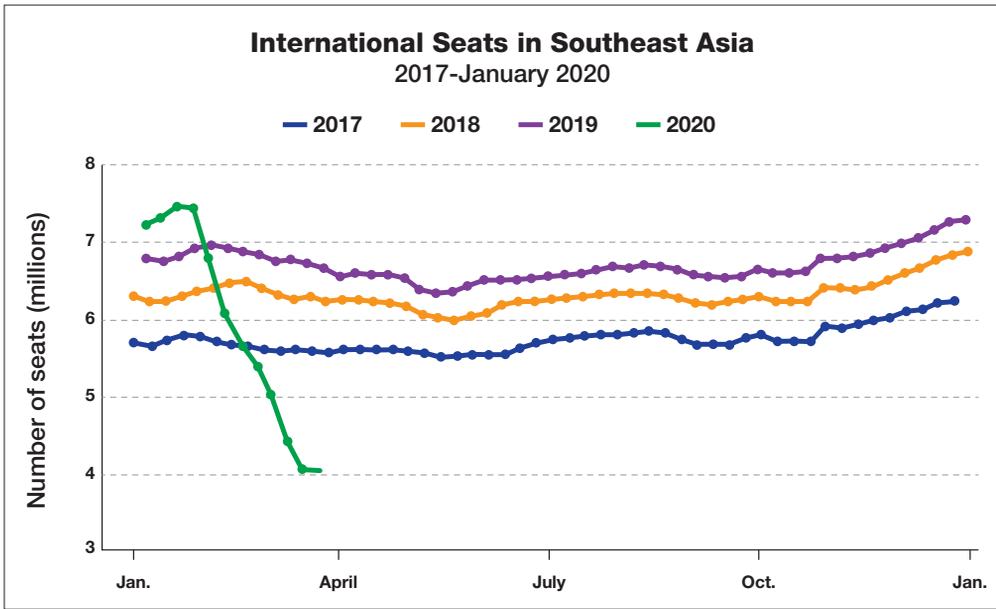
Source: CAPA - Centre for Aviation and OAG

only 30 daily flights from Frankfurt and 10 each from Munich plus three-times-weekly long-haul services to key destinations in Asia, Africa, Latin America and North America.

For the Middle East, IATA is pleading for “urgent emergency sup-

to companies hit by the sudden and dramatic drop in demand linked to the travel and social restrictions governments have put in place in a bid to slow down the spread of the COVID-19 virus.

Vestager also said the commis-



Source: CAPA - Centre for Aviation and OAG

government, and not just because the city is the capital. The authorities are also considering when to hold the annual parliament session there, the disruption of which by a renewed disease outbreak would cause an intolerable loss of face to the Communist Party.

The airports to which international flights are supposed to be redirected are Hohhot, Shijiazhuang, Taiyuan and Tianjin.

ASIA-PACIFIC

Airlines and governments in the Asia-Pacific region are implementing a range of measures as they scramble to adjust to sharp drops in passenger traffic.

South Korea was one of the markets hardest hit, since at one point it had the highest number of COVID-19 cases outside China. However, Seoul appears to have slowed the spread of the virus, and now the focus has shifted to the growing outbreak in Europe.

The country was one of the earliest markets outside China to be affected by travel restrictions imposed by other countries due to COVID-19. Korean Air had suspended 89 of its 124 international routes as of March 13, and international flights were down 86%.

Taiwan imposed new travel restrictions effective March 19, barring almost all foreign nationals from entry and requiring a 14-day quarantine for all passengers. The government is reportedly offering loans and subsidies to help local airlines.

In Southeast Asia, some governments are also effectively closing down international travel. In Malaysia, for example, foreigners are barred from entry, and Malaysian nationals are subject to a 14-day quarantine. Hong Kong is requiring travelers from all countries to undergo a compulsory self-quarantine.

Airline capacity and traffic has already plummeted at some of the region's key hubs. Hong Kong International Airport saw its international seats drop by 82% from Jan. 27 to March 16, according to data from CAPA - Centre for Aviation and OAG. For Singapore's Changi Airport, the decline over the same period was 40%.

Singapore Airlines has cut 50% of its capacity through the end of April and has indicated that further reductions are to be expected. "We have lost a large amount of our traffic in a very short time, and it will not be viable for us to maintain our current network," says CEO Goh Choon Phong. "Make no mistake—we expect the pace of this deterioration to accelerate [and the group] must be prepared for a prolonged period of difficulty."

Cathay Pacific has been severely affected by the restrictions in Hong Kong and elsewhere in the world. The airline's traffic was down 54% year-over-year in February, with load factor dropping 29 points to 53%. This resulted in a loss of HK\$2 billion (\$257.5 million) for that month alone. Passenger capacity fell 29%

in February, and the carrier has plans for a cut of 65% in March and as much as 90% in April, leaving what it describes as a "bare skeleton" operation.

Australian and New Zealand airlines are also adopting a variety of measures in response to the dissolving demand. The governments of both countries have banned foreign nationals from entering and require 14-day quarantine periods for their own citizens and permanent residents if they arrive from overseas.

Qantas has made major changes, sus-

pending all of the group's scheduled international flights from the end of March through at least the end of May. Domestic capacity will be down by 60%.

The carrier will also stand down two-thirds of its 30,000 employees for the same period. They will be able to use various leave programs, but some will have to take unpaid leave.

CEO Alan Joyce notes that Qantas has built up a strong financial position in recent years, which gives it some breathing room. "A lot [of airlines] will go under, but Qantas will not be one of them," he says.

Virgin Australia is suspending all of its international operations from March 30 to June 14, and 50% of its domestic capacity. This will entail the grounding of 53 aircraft. Virgin is less exposed to the international market than Qantas, with 78% of Virgin's flight revenue coming from the domestic sector.

The Australian government unveiled an aviation support package worth A\$715 million (\$415 million) that includes waivers and refunds for fuel excise taxes, domestic air traffic control fees and domestic aviation security charges.

Air New Zealand plans to cut long-haul capacity by 85% in the coming months, with capacity on its Australian routes down 80% and domestic flying reduced by 30%. The airline estimates it will need to reduce its workforce of 12,500 by up to 30%. 

Aerospace Manufacturing After COVID-19 Will Be Different

> OEMs SEEK GOVERNMENT AID IN WORST CRISIS IN A GENERATION

> AEROSPACE BUSINESS LIKELY TO SEE LONG-TERM RECASTING

Michael Bruno Washington, **Jens Flottau** Frankfurt and **Thierry Dubois** Lyon, France

The aerospace manufacturing industry has awakened to a nightmare. Already reeling from the Boeing 737 MAX grounding and shutdown, as well as narrowbody manufacturing issues at Airbus and softening widebody production across the board, the COVID-19 virus now is crippling worldwide air travel, the raison d'être for making airliners.

Although aircraft manufacturers and suppliers initially believed they were insulated from the worst of the outbreak's effects—because their business moves more slowly and the long-term air traffic growth theory still is seen as valid—the industry is quickly learning it is not a question of “if” but “when” it too will suffer.

Governments from Asia to America have told their residents to stay home, literally. Borders have been shut. Financial analysts see a global recession beginning. Airline failures are expected (see page 16).

In turn, aircraft order delays and cancellations already are happening, according to the International Air Transport Association. Financial analysts are paring back expected delivery forecasts this year from major OEMs. Manufacturers and suppliers, meanwhile, are wondering whether to shut down their factories to help stop the spread of COVID-19 or will do it anyway because orders will be delayed or canceled. None have announced such moves yet, but several have confirmed to Aviation Week they are reviewing business continuity plans.

Still, industry titans are moving to get ahead of the issue. Boeing, on March 17, sought a \$60 billion-plus bailout from the U.S. government for itself and ostensibly its supply chain, and the Chicago company recently drew down the entirety of its new credit line of nearly \$14 billion. The same day, Airbus shuttered production in France and Spain for four days. Triumph Group announced a fresh round of significant workforce cuts

and restructuring on March 18. Finally, Textron Aviation also announced it furloughed workers for a month.

Cameron Doerksen, an analyst at National Bank of Canada Financial Markets, says the COVID-19 pandemic “represents a clear threat to the sustainability of the current aerospace cycle.”

AlixPartners Aerospace and Defense Managing Director Eric Bernardini warns of worse. “This downturn will likely go deeper and last longer,” he writes.

“All aero bets are off,” echo Robert Stallard and Karl Oehlschlaeger of Vertical Research Partners. “Suffice it to say that aero suppliers are going to take it on the chin.”

The latest developments stand in stark opposition to public comments offered just weeks ago from industry leaders who said they did not expect much impact from the coronavirus crisis. While industry executives and advisors say it could take 1-2 quarters for the effects to hit their bottom lines, now they believe they must get ahead of the gathering downturn.

“It looks like we’re the last to get the memo,” the division chief of one major supplier tells Aviation Week. “Bottomline is it’s changing every day. It’s getting worse by the day. “When it comes back, it’s going to come back differently.”

Jefferies analysts Sheila Kahyaoglu and Greg Konrad cut their long-term narrowbody production forecast to a 3% compound annual growth rate from 5%, matching their widebody expectation of 3%. According to several analysts, advisors and executives:

- Widebody-related work is expected to ratchet down far further, although all aircraft manufacturing will see some degree of downturn;
- Narrowbody order delays and cancellations will climb;
- Aerostructures providers are seen as the most vulnerable sector;
- Publicly traded aerospace compa-

nies have almost universally suffered double-digit stock price declines and are looking to get ahead of the downturn;

■ Analysts and executives foresee a 20% or greater drop in commercial aftermarket revenue; and

■ Some number of smaller suppliers—already stretched thin with less working capital from years of OEM-led squeezes—are expected to go out of business.

“It concerns me how many small suppliers will be able to withstand this downturn from a cash perspective,” one mid-tier executive says. “Cash is king in this environment here.”

But first may come relief for Boeing, the world’s largest aerospace and defense conglomerate. “I think we have to protect Boeing,” President Donald Trump said on March 17 upon news of the OEM’s bailout bid.

Credit analysts understand why. S&P Global Ratings now believes Boeing’s free cash outflow will hit \$11-12 billion this year before turning to an inflow of \$13-14 billion in 2021, down from \$22 billion. The “much weaker” cash flow forecast led analysts there to downgrade Boeing’s credit from A levels to BBB. Fitch Ratings also is leaning toward downgrading.

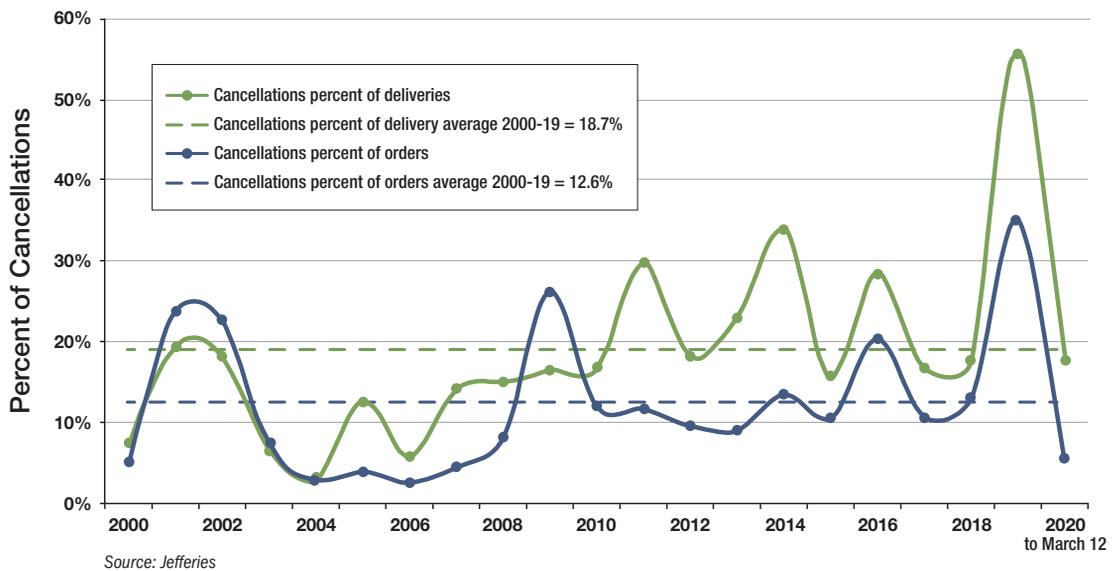
“Boeing enters this aerospace downcycle already wounded by MAX, and the question has started to be raised as to whether it can survive,” the Vertical analysts note. “Ultimately, we think the U.S. government will take the view that Boeing is too big to fail, but that could provide little comfort to equity investors.”

Boeing’s bailout bid leads those from airlines, airports or maintenance, repair and overhaul representatives. “This will be one of the most important ways for airlines, airports, suppliers and manufacturers to bridge to recovery,” Boeing says. “Funds would support the health of the broader aviation industry, because much of any liquidity support to Boeing will be used for payments to suppliers to maintain the health of the supply chain.”

Boeing asserts the long-term outlook for the aerospace industry “is still strong, but until global passenger traffic resumes to normal levels, these measures are needed to manage the pressure on the aviation sector and the economy as a whole.”

Analysts are less sure versus just weeks ago. “Even before the

Airline Order Cancellations as Percentage of Deliveries and Orders, 2000-20



COVID-19 crisis, demand for new aircraft had been softening,” Doerksen says. “We attribute this partly to the very strong order activity in prior years and the very long backlogs at Airbus and Boeing.”

Moreover, if airlines ratchet back on capacity growth and there are airline failures, he thinks there will not only be lower-order activity but also deferrals of existing orders. Almost 30% of Airbus’ backlog is in the Asia-Pacific region, according to the analyst, where most airlines have been hard hit by the crisis. Boeing has 25% of its backlog from airlines in Southeast Asia.

“We are also concerned about orders from lessors, because if there is now an oversupply of aircraft in the market and if airline failures accelerate, lessors will not need many of the aircraft they have on order in the short-to-medium term,” Doerksen adds.

Without identifying any bailout bid, Aerospace Industries Association President and CEO Eric Fanning says government action is necessary. “Few industries are more inextricably linked to our nation’s continued success and global competitiveness than aerospace and defense,” he says. “Right now, extraordinary challenges to our workforce and our heavily integrated supply chain are reverberating across America’s industrial base, which in turn is having a major and measurable impact on our economy.”

Across the Atlantic, Airbus has

to prepare for a massive, multiyear downturn that will see it get back to previous production volumes only past 2027 because much of its current backlog is disappearing as a result of deferrals and cancellations made by airlines and lessors trying to deal with the coronavirus crisis, analysts at Agency Partners forecast.

Production rates will be “cut increasingly rapidly through 2020 and 2021,” Agency Partners writes in a note to clients. “This will, in our view, expose the company to negative operational gearing, with the A330 and A350 both likely to fall into loss in 2021 and the A320neo profits halving.” Given that it is difficult for airlines to defer aircraft at very short notice, Airbus might still deliver a substantial portion of its targeted deliveries, albeit needing very substantial sales financing, the analysts say. “But 2021 will see an unmoderated downturn” with both Airbus Commercial and the group making losses. Airbus could see a cash outflow of more than €18 billion (\$19.4 billion) between now and the end of 2022.

Airbus sources tell Aviation Week that leadership is making “business continuity” its highest priority and is trying to avoid a complete temporary stop, because a ramp-up from zero would be extremely challenging, considering all the implications for suppliers. Airbus also has reinstated a group called “watchtower,” made up of representatives of production,

finance and customer relations. The crisis group was first set up in the 2008-09 global financial crisis and was primarily tasked with managing the multiple requests for deferrals and financing.

Indeed, business continuity is perhaps the biggest challenge of all. Industry remains almost singularly convinced that the long-term outlook still is positive, based on rising middle classes worldwide that want to travel for leisure.

“We know this situation will come to an end at some point; therefore, we are in a stop-and-go situation, which is very difficult to manage in manufacturing—especially for a complex product with an intense production rate,” says Jerome Bouchard, aerospace partner with Oliver Wyman.

But the further a supplier is from the OEM, such as Tier 2 or 3, the smaller it is and the more it specializes in a product. Therefore, for lower-tier suppliers, questions should be raised about survivability, Bouchard says.

Longer term, industry likely will come to believe as a whole that manufacturing and supply activities have been offshored to an excessive extent to cheaper, remote labor markets, Bouchard explains. When a wave of repatriation of the supply chain comes, France’s Tier 2 and 3 suppliers will better be able to make the most of it.

The same could be said of OEMs and suppliers everywhere, as it might be the only upshot of this crisis. ☪

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Know. Predict. Connect.

Emirates Airline says it sends deep-cleaning teams to disinfect aircraft cabins before departures from Dubai.



EMIRATES PHOTOS

COVID-19 Outbreak Ushers In New Cabin-Cleaning Techniques

- AS COVID-19 SPREADS, AIRLINES TAKE STRINGENT CABIN DISINFECTION MEASURES
- IATA MIGHT ADJUST EXISTING CLEANLINESS GUIDELINES

Kerry Reals London

Aircraft cabin-cleaning guidance could be revised in light of the ongoing global COVID-19 outbreak, as airlines scramble to convince nervous passengers that flying is still safe despite plummeting air travel demand.

At an International Air Transport Association (IATA) workshop in Singapore in early March, during which existing recommendations on cleaning and disinfecting aircraft cabins were discussed, members suggested the possibility of “reviewing and/or standardizing routine cleaning guidelines for aircraft,” the industry body says.

While IATA has determined that its existing guidelines “remain appropriate,” it says that “some minor adjustments [are] possible.” The trade group stresses that so far during the COVID-19 outbreak—which now affects more than 100 countries—“we have not seen evidence of [the virus spreading] during air travel, either in airports or on aircraft.” However, IATA’s forecasts of double-digit drops in

passenger numbers indicate that the traveling public remains unconvinced.

In a move to reassure passengers, a number of airlines have made public statements in recent days emphasizing the cleanliness of their aircraft cabins; for instance, in a YouTube video posted by Emirates Airline on March 8, the Dubai-based carrier says it is “working round the clock to ensure our aircraft cabins are the cleanest in the skies.”

Emirates says in the video that 248 of its aircraft are deep-cleaned every day before departing Dubai. It adds: “All our aircraft now undergo extensive, deep cabin-cleaning and disinfection—from windows, armrests, tray tables and TV screens to bassinets, lavatories and common areas.” In the case of aircraft with a suspected or confirmed case of COVID-19 on board, Emirates follows enhanced cleaning protocols, whereby cabins are “defogged and misted with special disinfectant.”

Greek carrier Aegean Airlines states that it has “amplified standard aircraft-cleaning procedures between

all its flights, both during the day and after the completion of flights at night.” The airline adds that it has established a process to work with “a specialized disinfection company in cases where a possible affected passenger is reported” by health authorities.

In the U.S., Delta Air Lines and United Airlines both issued statements via Twitter on March 6, linking to information on how they are stepping up cleaning procedures. Delta says it has “doubled down on its regular cleaning program” and has added a fogging process “to disinfect transoceanic aircraft interiors.” The process is more commonly used by the food industry.

“As transoceanic flights come in, fogging takes place after an initial cleaning, this time with tray tables lowered and overhead bins and lavatory doors open. Seatback entertainment touch screens are given an extra cleanse using disinfectant wipes,” Delta adds.

United says that in addition to thoroughly wiping down hard surfaces such as tray tables, window shades and armrests with a “high-grade disinfectant” and undertaking a “full decontamination process” for aircraft with suspected coronavirus cases on board, it will soon start using “an electrostatic fogger to disinfect the air and surfaces within the cabin on all international arrivals into our U.S. hubs, Honolulu and Guam.”

Airlines are also starting to look at specialized cleaning companies, whose usual customers include cruise

lines, food-processing companies and the hospitality sector, to see if their products could be applied to aviation.

One such company, Denmark-based ACT.Global, has seen “a massive spike” in inquiries from airlines about how its Premium Purity cleaning system could be used to disinfect aircraft cabins, Chief Technical Officer Christopher Luscher tells Aviation Week.

The system works by applying a transparent, odorless coating to all surfaces. When the coating is exposed to ambient lighting, a photocatalytic reaction takes place that, the company says, causes harmful microbes such as bacteria and viruses—including the coronavirus that causes COVID-19—to decompose. The process “accelerates the natural aging of microbes,” Luscher says.

The coating is effective for 12 months, although ACT.Global also recommends daily cleaning between the annual coatings because spillages and dust buildups can form a barrier between the lighting and the coating, reducing its effectiveness. The company has developed a water-and-salt-based cleaning product for this purpose that, it says, can be used without protective gloves or masks because it “replaces strong chemicals and disinfectants.”

For airlines with short turnarounds, Luscher acknowledges that cleaning protocols would “need to be balanced” with the amount of time available between flights. He cautions, however, that if one airline passenger is infected with the coronavirus, then the aircraft cabin “effectively becomes an incubator where the virus can spread from passenger to passenger.” Viruses can live on surfaces for an average of 4-5 days, sometimes longer, he adds, so if an infected passenger sneezes near a hard surface, “small droplets will persist for a number of days.”

The World Health Organization (WHO) says on its website that although “it is not certain how long the virus that causes COVID-19 survives on surfaces,” it seems to behave like other coronaviruses. “Studies suggest that coronaviruses (including preliminary information on the COVID-19 virus) may persist on surfaces for a few hours or up to several days,” the WHO states.

Luscher admits that the airline industry was “not our intended segment” but says the COVID-19 outbreak “has illuminated an issue.”

“We’re working on getting into air-

craft cabins very soon, and there is a long list of [airline] inquiries that we’re in dialog [about] now,” Luscher says. “We would be able to apply [the coating] more or less immediately after an operator [receives approval to use it].” The product takes about 4 hr. to apply.

Challenges unique to aircraft cabins, however, could limit the effectiveness of the system. “The issue with aircraft is it’s a tight space with dimmed light, so there are still times when you have risk profiles,” Luscher admits.

Nonetheless, ACT.Global is “pitching to airlines” to consider applying the coating to “primary contact points” such as aircraft lavatories in the first instance, although the system can also be applied to seats, tray tables and other surfaces within the cabin.

Four years ago, Boeing unveiled a self-cleaning lavatory concept that uses ultraviolet light between each use “to destroy all known microbes.” The airframer says it tested what it now calls the Fresh Lav on the 777 ecoDemonstrator in 2019. Its integration into “the cabin of the future will be paced by market interest and technology development,” Boeing adds.

Market interest for such products could increase on the back of the COVID-19 crisis. Aircraft seats manufacturer Recaro is preparing for an “influx of requests” for a self-cleaning seat it has developed, CEO Mark Hiller tells Aviation Week. “As of now, this hasn’t happened. Nevertheless, we expect an increased demand for antibacterial materials as soon as the travel bans decrease,” Hiller says.

Recaro has designed a “nano coating” that it says provides long-lasting antibacterial protection for aircraft seats. “The coating cannot be recognized by passengers. It contains an antibacterial active substance and can be applied on almost all seat components that have direct contact with the passenger,” Hiller says, adding that the coating can “reduce costs and optimize cleaning procedures for airlines.”

Because COVID-19 is a viral rather than a bacterial infection, however, Recaro cannot claim its effectiveness against the coronavirus. “In order to state that this coating type is effective against [COVID-19], we would need to test the virus SARS-CoV-2, which is not the case yet,” Hiller says. Nevertheless, he believes general hygiene and cleanliness will be at the forefront of passengers’ minds follow-

ing the coronavirus headlines.

“A global crisis like we see today certainly raises the awareness among passengers on hygienic topics while traveling,” Hiller says. “People have a need to feel safe and secure, and our products cater for this very personal need. We expect the solution we offer will become more important for airlines around the globe and will add to the overall value proposition of the airline.”

Passengers are not the only ones concerned about safety. The Association of Flight Attendants (AFA) is pressing airlines to provide “proper resources and procedures to mitigate risk to working crews.” The union’s recommendations include encouraging passengers and crew to avoid travel while sick by removing penalties for altering plans or work schedules and covering all medical costs and lost wages for aviation workers who are exposed during their work.

Airlines “have not fully implemented the recommendations,” the AFA says, but managers “have taken actions that exceed CDC [Centers for Disease Control and Prevention] guidelines and instruction.” The CDC’s recommendations for cabin crew include frequent handwashing with soap and water for at least 20 sec., the use of alcohol-based hand sanitizer with an alcohol content of at least 60% when soap and water are not available, the separation of sick travelers by a distance of 6 ft. (2 m), and the wearing of medical gloves when helping a sick passenger or touching potentially contaminated surfaces.

It is not yet known how long the COVID-19 virus will continue to spread before tapering off. What is clear is that it is not the first virus to affect demand for air travel, and it probably will not be the last, as the airline industry knows only too well after having suffered the effects of the Severe Acute Respiratory Syndrome (SARS) epidemic of 2003 and 2009’s swine flu outbreak.

“Other [viruses] will occur over and over again, and they will mutate and jump species,” Luscher says, adding that the COVID-19 outbreak—which has already affected thousands more people than SARS—could usher in more stringent aircraft cabin-cleaning regulations.

“I would imagine the airline industry would be forced to have better hygiene protocols in lavatories and food-handling areas,” he says. “For the cabin itself, [disinfection rules] are more likely to be recommended than enforced.”

Ethiopian MAX Crash Report Deflects Attention From Pilots' Role

> FOCUS IS ON FAILURES OF MAX FLIGHT CONTROL SYSTEM

> FLIGHT CREW PERFORMANCE IS NOT ADDRESSED

Sean Broderick Washington

The Ethiopian Accident Investigation Bureau's interim report on what happened to Ethiopian Airlines Flight 302 points to mistakes Boeing and the FAA made in designing and certifying the Boeing 737 MAX and to deficiencies in recommended pilot training as the primary factors in the accident sequence. The report offers little insight into flight crew actions or training, signaling that investigators do not see pilot performance as a factor in the disaster.

Released March 9, a day before the one-year anniversary of the Ethiopian Airlines Flight 302 (ET302) accident, the 136-page report says all analysis will be included in a final version. The facts laid out dive deeply into the 737 MAX's Maneuvering Characteristics Augmentation System (MCAS) flight control law, which provides automatic horizontal stabilizer input in certain flaps-up, manual flight profiles.

The MCAS is at the center of the crash of ET302 and that of Lion Air Flight 610 (JT610) in October 2018. In both accidents, the MCAS was activated by erroneous data from one of the MAX's two angle-of-attack (AOA) sensors, triggering a series of unneeded, automatic nose-down inputs that confused and ultimately overwhelmed the crews.

The MCAS' existence became widely known following the JT610 accident. The FAA issued an emergency airworthiness directive in early November 2019 that explained the system's function and failure modes but did not use the MCAS name. Boeing quickly followed up with an airline operators' message that referenced the MCAS specifically, introducing it to most pilots for the first time.

While the first accident was enough to prompt Boeing to start work on changing the MCAS software—part of a series of MAX updates that are still not finalized—the system was not thrust into the spotlight until after the ET302 accident. Existence of the FAA directive and the Boeing message are

two key differences between the JT610 and ET302 accidents: The Lion Air crew had no idea the MCAS existed, but the ET302 crew apparently did.

The bureau's report says the government-owned airline revised its MAX flight manuals on the day the directive was released. Many carriers and pilot

were given additional information or new procedures related to the MCAS.

The interim document also does not dig into several other areas that usually interest investigators and often end up in accident reports. Information on the crew's training history is limited to basic facts, such as dates of when type ratings were earned and proficiency checks completed. There are no specifics on how each pilot performed.

Similarly, details on the airline's flight-training program are limited to its academy's capabilities. Absent from the report is any discussion about the carrier's standard operating procedures or its 737-specific curriculum—information that investigators often

Wiring modifications are now among the fixes Boeing must make before the MAX can fly again.



work groups issued detailed memos on the MCAS to their pilots following Boeing's revelation that the system existed and was linked to JT610. Some airlines modified their preflight briefings and added information from the directive, such as the signs of an AOA failure and a reminder to follow appropriate checklists, including "stabilizer runaway." This helped clarify a key and ultimately wrong assumption Boeing had made during the MAX's development: Pilots would quickly diagnose an uncommanded MCAS activation as runaway stabilizer and therefore did not need details on how the system worked. The report does not say whether Ethiopian's crews

use to frame facts detailed in the report or highlight deviations.

One key observation made in the preliminary report released a month after the accident is not revisited in the more detailed interim report. Among the findings in the April 2019 initial update on the probe: The crew "performed runaway stabilizer checklist" during their troubleshooting but could move the stabilizer with the manual trim wheel. The new report confirms the stabilizer-trim cutout switches were toggled, and the pilots attempted to use the manual trim wheel. But the report does not discuss any checklists nor offer evidence that the pilots referenced them.

The ET302 crew's reactions to the MCAS activation included pulling back on their control yokes and using yoke-mounted electric-trim switch inputs to counter the automatic stabilizer nose-down commands. But the pilots did not counter all the MCAS input. The faulty AOA data continued to trigger the automatic pitch-adjustment function, and the aircraft became more out of trim and harder to keep from descending as the 6-min. flight progressed.

The 737 stabilizer positions range from 0 trim units aircraft nose-down to 17 units nose-up, with 4 being neutral. These correspond to a range from 4.2 deg. nose-down to 12.9 deg. nose-up.

When ET302 departed, the stabiliz-



SEAN BRODERICK/AW&ST

er was at 5.6 units, “a consistent setting for the takeoff,” the report says. “During takeoff roll, the engines stabilized at about 94% N1,” or low-pressure compressor rotation speed. “From this point for most of the flight, the N1 reference remained about 94%.”

Shortly after the 737-8 lifted off from Addis Ababa Bole International Airport Runway 07R, the aircraft's left-side AOA value began to fluctuate wildly. “As a result of the erroneous left AOA value, the left [captain's] stick shaker activated,” the report says. It remained active throughout the flight.

The faulty AOA data set the stage for the MCAS to activate once ET302's

pilots retracted the flaps. The MCAS trimmed the stabilizer nose-down from 4.6 units to 2.1 units. The crew responded with 2 sec. of column-mounted manual electric-trim inputs, moving the stabilizer to 2.4 units.

Five seconds after the crew stopped its trim inputs, the MCAS—still sensing the faulty AOA data—activated again. The stabilizer moved to 0.4 units in 6 sec. before the crew interrupted it with 9 sec. of electric-trim input, moving the stabilizer to 2.3 units.

After the second MCAS activation, the crew toggled stabilizer-trim cutout switches, which prevented the trim motor from moving the stabilizer but also left pilots with only the hand-operated trim wheel to move the flight-control surface.

Aerodynamic forces created during a runway-stabilizer scenario can render the trim wheel, mounted between the pilots on the center pedestal, nearly impossible to crank. If one pilot is pulling back on the yoke—a natural reaction to counteract uncommanded nose-down inputs—the force on the elevator, part of the horizontal stabilizer, increases. This makes the stabilizer harder to move. Add in an airspeed increase that a nose-down attitude introduces, and the situation becomes more difficult. This is what the ET302 crew faced.

When the pilots attempted to adjust the stabilizer manually, the mis-trim was 2.5 units, the report says. The aircraft's airspeed—its thrust levers still where they were at takeoff—soon exceeded its maximum 340 kt. This triggered an overspeed “clacker,” or alert, that was active for the flight's final 2 min. 30 sec.

“By the time the [first officer] tried to move the trim wheel manually, a force between 42-53 lb. was required according to the aircraft manufacturer computation,” the report says. Investigators determined that the ET302 crew would have needed 40 turns of the wheel to correct the 2.5 trim units. Simulator trials done as part of the probe found that difficulty in turning the wheel increased as airspeed and amount of mis-trim increased. Investigators concluded the trim wheel was “not movable” at airspeeds higher than 220 kt. and mis-trim values of 2.5 units or more, the report says.

Unable to crank the trim wheel, the ET302 crew toggled cutout switches back to “normal,” which the runway-stabilizer checklist says should not be done. This set up the MCAS—

still receiving the faulty AOA data—to activate again. The ET302 crew initially was able to climb but could not counter the MCAS nose-down inputs. The aircraft pitched over, sped up and impacted the terrain, killing all 149 passengers and eight crew members. Stabilizer trim components recovered at the crash site show the stabilizer's final position was 2.5 units, or 1.5 deg. aircraft nose-down.

The ministry's report makes clear that faulty AOA data started the fatal accident sequence because the MAX's flight control computer software detected, erroneously, that the aircraft's nose was too high. That activated the MCAS and the series of nose-down stabilizer movements. Boeing's MAX training, which did not cover the MCAS system, “was found to be inadequate.”

The failed JT610 AOA sensor resulted from a supplier's improper calibration. The Ethiopian report does not say why ET302's vane failed.

Also absent from the report: a cockpit voice recorder (CVR) transcript or synopsis that would add context to the pilots' actions. CVR conversation could help explain whether the captain cross-checked his instruments with the first officer's when the single stick-shaker activated, or why the crew did not reduce the aircraft's engine power settings.

The accident investigation bureau, part of Ethiopia's transport ministry, provided draft copies of the interim report to U.S. parties participating in the probe, including the FAA and NTSB, less than a week before it was publicly released. The draft report had included a probable cause, sources familiar with its contents confirmed. The bureau's conclusion: The MCAS caused the accident. Pushback from parties arguing in part that an incomplete investigation cannot have a conclusion led to the probable cause's removal.

The FAA says it is “important to have the full final report to evaluate it against other independent reports so that we might fully understand all of the factors—both mechanical and human—that played a role” in the accident.

Boeing is working to finalize changes to the MAX, including MCAS revisions and updated training. It also will reroute stabilizer motor power wires on all stored MAXs to bring them into regulatory compliance before they are delivered. Boeing is quietly optimistic that the FAA's approval will come around midyear. ☛

Britain's EASA Exit Decision Is Built on Ideology Rather Than Pragmatism

> UK WILL LEAVE EASA ON DEC. 31

> CAA IS BEGINNING RECRUITMENT DRIVE FOR NEW ROLE

Tony Osborne London, **Bill Carey** Washington, **Thierry Dubois** Lyon and **Jens Flottau** Frankfurt

Ever since Brexit became a possibility, aerospace has warned that remaining a member of the European Union Aviation Safety Agency (EASA) would be critical to keeping industry competitive and free of disruption.

However, with the British government planning a clean break from the European regulator at the end of 2020—the end of the Brexit transition period—those warnings appear to have fallen on deaf ears.

The UK's Civil Aviation Authority (CAA) will take over responsibility for aircraft certification and regulation from EASA, British Transport Secretary Grant Shapps told Aviation Week editors in Washington on March 7. However, the decision appears to be built on political ideology rather than the benefits it provides to industry.

Like Brexit—which was about settling long-running divisions in the ruling Conservative Party but ultimately divided a country—a break with EASA comes from the British government's refusal to accept any role by the Court of Justice of the European Union (CJEU). The court is the ultimate arbiter of EASA rulings. "We can't be subject to the rules and laws made by somebody else," Shapps says.

Yet these issues are not a problem for countries such as Norway and Switzerland, both sovereign states that are full EASA members outside the European Union.

Giving EASA oversight the chop was always an option for post-Brexit Britain and would have been the default had the UK fallen out of the EU without a deal.

But in what appears to be a microcosm of Brexit, albeit with stronger support to remain, an EASA exit goes against the advice of Britain's £36 billion (\$46.6 billion) aerospace and defense industry and even the regulator. On top of that, there are questions about whether the CAA will be ready

to go it alone in just nine months' time.

The CAA's public statements on Brexit, including one on its website, say the "most positive outcome" for UK consumers and the aviation industry would be "continued participation" in EASA.

"In our opinion, the CAA does not have the expertise required to operate as a world-class safety and technical regulator," said a strongly worded statement from International Airlines Group (IAG), the owner of UK flag carrier British Airways. The CAA would need "fundamental restructuring from top to bottom," IAG said. "There is no way that it can be done by Dec. 31."

Shapps also appears to admit the CAA may not be ready straightaway. "The expertise will need to come home to do that, but we'll do it in a gradual way," he says.

The CAA confirmed it has made



UK Transport Secretary Grant Shapps

BILL CAREY/AW&ST

"comprehensive plans" to prepare for a possible departure from EASA. The agency also said it plans to be ready to take on State of Design responsibilities again, which had previously been delegated to EASA in 2003.

"As part of our planning, we have already recruited full-time employees in positions across the CAA," a CAA spokesman said. "We will continue to refine these plans over the coming months, which may require additional staff, including in the areas of State of Design."

The CAA also confirmed it has been working with the Department for Transport to incorporate all current EU aviation law into UK domestic law "so that there will be no immediate change to the regulatory framework at the end of the transition period." It continued: "We will work

with the government and the industry on any changes to the framework after this point."

EASA said it is "well prepared for the departure of the UK" because the agency put measures in place in case of a hard Brexit before the withdrawal agreement was signed, officials say.

Since EASA's formation in 2002, the UK has been one of the leading lights in the creation of the organization. Much of the agency's legislation and regulations have been developed from that

The UK Civil Aviation Authority last year relocated its headquarters from Central London to Aviation House (pictured) in Crawley, England, near Gatwick Airport.



CAA

written by the CAA. But since Brexit took place Jan.31, the UK has become a third country in the EASA ranks—in other words, a country outside of the EU member states, making it a rule taker and no longer a rule-maker.

By creating its own regulatory system, the British government will be “incurring substantial costs to build up the capabilities of the CAA to match the standards required for recognition by EASA and the FAA in the U.S.,” said Paul Everitt, CEO of the ADS Group, a UK aerospace, defense, security and space trade association. ADS has been vocal about the UK maintaining regulatory alignment with Europe and had been receiving positive noises from government about continued membership of the agency.

ADS has previously suggested that handing EASA’s responsibilities to the CAA could take up to 10 years and cost up to £40 million annually to create a UK safety authority with all the expertise of EASA and the FAA, against current annual UK contributions to the agency of £1-4 million. “[The government] will be gambling that companies can absorb the additional costs and complications created by regulatory divergence without an impact on their future investment in the UK and that [the] disruption will have no impact on safety,” Everitt warned.

Industry has some time to prepare. Companies that had already prepared for a no-deal Brexit during 2019 had an EASA exit in their basic planning

assumptions, several aerospace companies told Aviation Week.

UK-based suppliers producing parts for an EASA-certified aircraft will have to keep their EASA approvals to produce those parts. CAA approvals will be an additional cost. “The result is just additional red tape,” says Jerome Bouchard, aerospace partner at Oliver Wyman. It remains to be seen whether products delivered in the UK will need an extra certification.

“We hope for a bilateral agreement that would allow us to deliver our products with an EASA or FAA certificate,” says Muriel Menudier, Safran’s senior manager of aviation safety and regulations. “This will be part of the outcome of the ongoing negotiation [between the European Commission and the UK government], but the deadline is close.”

A spokesman for Boeing said: “Maintaining a high degree of freedom of movement for aerospace goods and closely aligned regulatory cooperation post-Brexit are important to the growth and competitiveness of European industry and the safety of European citizens.”

So far, the British government has been careful to skirt the subject of an EASA exit since the UK’s EU membership referendum in June 2016. The most recent document about the UK’s approach to negotiating a future relationship with Europe calls for the establishment of a Bilateral Aviation Safety Agreement (BASA) that recognizes aviation safety standards and regula-

tory cooperation between the CAA and EASA. “The BASA should be in line with existing EU precedent for cooperative aviation safety arrangements with third countries,” the document states.

Shapps believes the clean break from EASA will allow a strengthened CAA to become more forward-looking and supportive of technology developments for electric propulsion and urban air mobility. “We’ll make sure our legislative framework is in a great place to enable those kinds of organizations to excel in the UK market,” he says.

“The UK CAA may create relatively flexible rules for the country’s industry to benefit from,” Bouchard suggests. But the UK’s electric vertical-take-off-and-landing industry has yet to prove it is competitive, while the market is embryonic, he adds.

Bouchard also notes that the trend for certification rules is to become stricter, not more flexible, particularly considering the Boeing 737 MAX crisis.

ADS points out that the companies taking steps toward greener aviation “are clear that EASA is the best option for the UK.”

“Participation in EASA has already contributed to ever-improving safety standards in aviation, given us influence in one of the two major global regulators and eased access to our export markets—not just in Europe but around the world,” Everitt said. Leaving EASA, on the other hand, “is a gamble with much at stake but without any clear prize on offer,” he noted. ☛



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UK Regions Could Suffer From Flybe Failure Fallout

> FLYBE STRUGGLED TO COMPETE AGAINST LOW-COST CARRIERS

> REGIONALS STEP INTO ROUTES LEFT OPEN BY FLYBE'S DEMISE

Tony Osborne London

The finger-pointing has begun in the public blame game surrounding the collapse of British regional airline Flybe.

Workers' unions and air transport associations have turned their ire on the government, blaming ministers for not making reforms to the UK's controversial air passenger duty (APD) tax and reneging on financial support it had offered to Europe's largest regional airline.

Officials in the British aviation industry are warning that more airlines could fail, particularly as demand for air travel tails off in the face of the COVID-19 outbreak.

Flybe is the fourth British airline to fail in three years.

"Right now, there is a strong case for the government to suspend APD for the next six months and make significant reductions in the longer term to help this struggling industry," said British Airline Pilots Association General Secretary Brian Strutton.

The government's view coincided with that of its shareholders, the Connect Airways consortium, that bailing out the airline with private or public funds—as the government proposed in January—would have simply been throwing good money after bad.

"Unfortunately, in a competitive market, companies do fail, but it is not the role of government to prop them up," said British Transport Secretary Grant Shapps.

Although the impact of COVID-19 has been widely blamed for Flybe's downfall, it was merely the straw that broke the camel's back and just one in a litany of troubles that had plagued the airline for more than a decade.

Born out of more humble beginnings—serving the Channel Island of Jersey—the company undertook a rapid expansion, buying a large fleet of Embraer jets and Bombardier Q400 turboprops before rebranding itself as a full-service, low-fare airline to compete with Britain's railway network. But it was not long before the

leasing costs of the new fleet were tugging on the bottom line, and subsequent CEOs—four in seven years—attempted to scale the fleet back to a more sustainable size.

The airline had been praised for linking the British regions, but it had also been derided by competitors for maintaining loss-making routes, many

committed in January 2020, alongside a time-to-pay arrangement with HM Treasury for APD to the value of £3.8 million.

"Sadly, despite the efforts of all involved to turn the airline around, not least the people of Flybe, the impact of COVID-19 on Flybe's trading means that the consortium can no longer commit to continued financial support," Virgin Atlantic said.

Virgin's previous plans to use Flybe for its own regional and feeder services for its long-haul flights have now been shelved, but the airline says it will "explore options" to connect its services with UK regions in due course.

Flybe finally halted operations on March 5, leaving its fleet scattered



TONY OSBORNE/AWAST

Flybe was the largest operator of the De Havilland Dash 8-400. The fleet, spread across airports all over the UK, is now grounded.

of which were seasonal and low-yield in nature, and for trying to compete with more efficient low-fare carriers like EasyJet and Ryanair on pricing.

APD weighed on demand for flights, too, with the tax immediately adding £26 (\$34) for a return domestic journey.

By contrast, flights into Europe are charged only once, on departure from a UK airport.

But even after the Connect Airways consortium—a group made up of UK long-haul carrier Virgin Atlantic, regional aircraft franchise operator Stobart Air and investment fund manager Cyrus Capital Partners—purchased Flybe, the airline continued to burn through money.

Virgin Atlantic officials said the consortium had invested more than £135 million over 14 months to keep the airline flying, including approximately £25 million of the £30 million

across the country and administrators to liquidate the business. However, Flybe's Aviation Services business is unaffected by the collapse and continues to operate normally.

Of greater concern though is the fallout. At a time when the government is calling for greater regional connectivity, the loss of Flybe will be sorely felt at some of the UK's regional airports.

Flybe was the monopoly operator on many of its 120 routes. The company also provided the majority of air services at Southampton, Belfast City and at Exeter airports and around half of the services to Cardiff in Wales and to Jersey and the Isle of Man.

Some airlines have begun stepping into the gap left behind. Scottish regional Loganair announced it would take on several of Flybe's Scottish routes, and Alderney-based Aurigny Air Services will fly routes from

Guernsey to Exeter and Birmingham.

Meanwhile, Flybe's franchise operators, including Blue Islands and Eastern Airways, announced they were in the process of restoring their own booking engines—having been reliant on Flybe's systems.

However, many of the routes are likely to go unfulfilled, particularly when air travel demand is shrinking

due to COVID-19. Unions fear knock-on effects that could see hundreds of airport workers lose their jobs, on top of the 2,000-strong Flybe workforce already redundant. A lack of services could also drive more British regional airports out of business, they fear. Several have already closed or even nationalized in recent years (*AW&ST* Oct. 27, 2014, p. 37).

The UK Treasury confirmed on March 11 it would review APD and its impact on regional air services, confirming it plans to issue a consultation in the spring. The government will “consider the case” for changing the APD treatment of domestic flights and look at introducing a “return leg exemption” as well as increasing the number of international distances bands. ☑

Europe's LCCs Embark On New Partnerships

- > WIZZ AIR'S ABU DHABI JOINT VENTURE IS SEEKING AN AOC
- > MIDDLE EAST ENTRY MAKES SENSE FOR CENTRAL/EASTERN EUROPEAN-FOCUSED WIZZ AIR

Helen Massy-Beresford Brussels

Europe's low-cost carriers have been faring better than their legacy counterparts, enjoying strong growth in recent years, but they cannot rest on their laurels. Wizz Air's move to launch a joint venture in Abu Dhabi, United Arab Emirates, underlines the innovative strategies budget carriers are adopting to keep thriving in an ever-more difficult aviation market.

Having rapidly expanded its Airbus A320-family fleet and route network in recent years, Budapest, Hungary-based Wizz Air is now poised for more growth beyond its Central and Eastern European heartlands and is in the process of obtaining an air operator's certificate (AOC) for Wizz Air Abu Dhabi, set up through a joint venture with Abu Dhabi-based holding company PJSC.

Operations are set to launch this autumn, and recruitment will begin in the coming months.

Describing the move as an “important milestone,” Wizz Air CEO Jozsef Varadi said on March 3: “Wizz Air's mission feeds into Abu Dhabi's diversified economic strategy, as we aim to stimulate traffic by creating demand

to the benefit of growing Abu Dhabi's touristic and economic diversity.”

The airline believes Wizz Air Abu Dhabi's fleet could number 50 within a decade, flying 15-20 million passengers per year. Routes will initially focus on Central and Eastern Europe before branching out to Middle Eastern, Asian and African destinations.

Wizz Air also foresees a market potential of 5 billion passengers within eight flying hours of Abu Dhabi, and



Wizz Air is looking east for growth.

says the low-cost carrier (LCC) sphere is underdeveloped compared with Europe. “We have a business model that stimulates the market, and we will take that model and our lower costs to Abu Dhabi,” Varadi said.

“Wizz Air has achieved success by consolidating its business around Central and Eastern Europe and by dominating routes between second cities that are not tourist hot spots,” says Ralph Hollister, travel and tourism analyst at data and analysis platform GlobalData. “Wizz Air's new partnership is another example of this broad strategy of differentiation.”

The Abu Dhabi joint venture provides Wizz Air with a vast new source market “whilst its European competitors will still be operating in markets much closer to reaching maturity,” Hollister says.

Before the full extent of the COVID-19 crisis was starting to become apparent, GlobalData forecast that outbound flights from the UAE would reach 3 million by 2023, growing at a compound annual growth rate of 3.1% between 2019 and 2023.

However, Wizz Air's push into new territory will not be unchallenged; Etihad Airways and Air Arabia are also in the process of establishing their own LCC, which is set to begin operating in the coming months and is also hoping to capitalize on growing tourism in the region.

John Strickland, director of JLS Consulting, sees Wizz Air's Abu Dhabi move as a reflection of the emirate's strategic wish to boost point-to-point tourism traffic and provide feeder traffic for Etihad Airways' long-haul services.



The venture makes sense for Wizz Air, too, he says, especially given the large quantity of aircraft the LCC still has on order. “It gives Wizz Air somewhere to place a number of the Airbus A321LRs due to arrive in the fleet in the next few years,” Strickland says. “They know they can generate traffic on these kind of routes because they have already done it on routes to Dubai. And it builds on Wizz Air’s strength in Central and Eastern Europe, where it understands the market drivers. It should be able to attract price-sensitive travelers looking to connect from Abu Dhabi on to all points east.”

It is increasingly important for LCCs such as Wizz Air to maintain focus on routes and partnerships that are not yet dominated by Ryanair or EasyJet, in order to differentiate in a highly competitive industry, Hollister adds.

Wizz Air is not the only LCC that has been shaking up the business model in a bid to drive growth. EasyJet has opted to team up with other airlines, both legacy carriers and long-haul LCC counterparts, through a con-

necting platform, EasyJet Worldwide, which the British airline launched in 2017. EasyJet initially partnered with Norwegian Air Shuttle and WestJet to begin connecting flights to long-haul services and enable passengers to buy other carriers’ flights on the EasyJet website. Cathay Pacific Airways, Emirates, Corsair and China Airlines are now also among the partners.

Europe’s biggest LCC, Ryanair, has looked beyond the LCC model, transitioning into a holding structure made up of four airlines—Ryanair DAC, Buzz, Laudamotion and Malta Air, the startup it bought in June 2019.

Ryanair said at the time that Malta Air would start operating with six aircraft in the summer of 2020, growing the fleet to 10 within three years and serving destinations across Europe and North Africa.

The airline has said more consolidation is an inevitable consequence of the COVID-19 crisis—as an already tough operating environment gets tougher and airline collapses mount—but will Ryanair look to add

more brands to its portfolio? It seems unlikely at the moment.

Strickland does not believe making a move for either of the industry’s most recent casualties would make sense for Ryanair: Flybe’s fleet of small Bombardier Dash 8 Q400 and Embraer 175 aircraft and regional routes would add more complexity than anything else.

As for Air Italy, “Ryanair is already the biggest airline in Italy through organic growth and would not be interested in Air Italy’s long-haul activities,” Strickland says. “Why would they need to add complexity instead of continuing to grow organically?”

Ryanair still has its work cut out with Laudamotion—more than a year after its acquisition—and that should serve as a cautionary tale for the airline, Strickland believes. “Lauda has been a substantial loss-maker,” he says. “If another airline without Ryanair’s cash resources had made that move, it may have dragged them down.”

—With Kurt Hofmann in Vienna

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Quantifying ADS-B 'In' Benefits

- > ACSS CERTIFIES ADS-B IN SYSTEM ON A321
- > EVALUATION STARTS WITH FIRST AIRCRAFT

Bill Carey Washington

Technology early-adopter American Airlines, avionics supplier ACSS and the FAA will gather data and report on the benefits of automatic dependent surveillance-broadcast (ADS-B) In applications to the wider industry.

Under a memorandum of agreement signed in 2016, the parties are collaborating on the ADS-B In Retrofit Spacing (AIRS) evaluation to demonstrate the “operational feasibility” of

ed TCAS, terrain awareness warning system (TAWS) and Mode S transponder with ADS-B In/Out capability—is fitted on the 100 new A321neos Airbus is delivering to American Airlines.

Originally as US Airways, with which it merged in 2013, American Airlines has worked with ACSS for nearly a decade to achieve ADS-B In capability.

The airline completed certification flight tests of SafeRoute+ on the A321 on Oct. 27, 2019, at Phoenix Sky

Now that the FAA requires all aircraft to signal their position by ADS-B Out, American Airlines pilots will be able to test one of the first planned ADS-B In applications—cockpit display of traffic information-assisted visual separations (CAVS)—using other carriers’ aircraft as reference targets.

A visual approach procedure, CAVS allows pilots to maintain separation from other aircraft during challenging visual conditions by showing the differential ground speed between a lead and own-ship aircraft on the AGD.

“They don’t have to follow another American A321 to perform the operation—they can follow Southwest, Delta, whoever,” Manberg says. “ADS-B Out is a rich operation now, so there is a lot of opportunity to be able to perform those operations. And we’ll be gathering data as a part of that.”

Other ADS-B In applications that will be demonstrated during the evaluation are Enhanced Airborne Traffic Situational Awareness—which is

A CAVS approach is visible on the ADS-B Guidance Display.

used from takeoff to landing to display surrounding airborne traffic relative to own-ship position—and interval management (IM), which helps pilots maintain time-based spacing.

The use of IM supports both airline block-time predictability and FAA ground-delay program planning to manage demand at arrival airports. It will be evaluated within airspace managed by the FAA’s Albuquerque air route traffic control center for two westbound flights approaching PHX.

SafeRoute+ is not the first operational ADS-B In system. Airbus previously certified an Airborne Traffic Situational Awareness (ATSAW) system on its A320, A330 and A350 types that provides ADS-B In functionality using TCAS processors from ACSS, Honeywell and Collins Aerospace. ATSAW is offered as a line-fit option or through service bulletins for retrofit.

Airbus reports that 229 A320s have been delivered with the ATSAW function selected as a line-fit option since the system was certified in 2010 plus another 80 A330s after ATSAW was certified on that type in 2010.

The manufacturer has also delivered 155 ATSAW-equipped A350s since the newer widebody airliner entered service in 2015. 🌐



displaying and exploiting aircraft targets produced by ADS-B Out broadcasts on the flight deck using an ACSS retrofit avionics system.

American Airlines started installing the ACSS SafeRoute+ system on its fleet of Airbus A321s in January; it plans to equip 319 of the narrowbody airliners over the next 4-5 years. ACSS says it is also working with a second U.S. carrier that plans a smaller-scale evaluation of the retrofit ADS-B In system.

SafeRoute+ is a software upgrade to an aircraft’s traffic alert and collision avoidance system (TCAS 3000SP) or T3CAS surveillance processor that avoids panel modifications on the flight deck by using the existing multifunction control and display unit and primary flight displays with the addition of a small ADS-B Guidance Display (AGD) in place of a mechanical standby instrument.

The T3CAS system—an integrat-

ed Harbor International Airport (PHX) in Arizona.

Late last year, the FAA granted Technical Standard Order-C195b authorization of the SafeRoute+ software and AGD and issued a supplemental type certificate to install the system on the A321.

The AIRS partners are “actively capturing data” from the first equipped A321, a retrofit of the aircraft used for the certification flight tests, says Chuck Manberg, ACSS’ lead ADS-B engineer. Plans call for producing an initial report on ADS-B In operational benefits in 2021, after more aircraft have joined the evaluation.

“This is a large-scale demonstration effort to be able to quantify those benefits,” Manberg says. “More than likely, we will extend the contract as well. There are other opportunities that we’re pursuing, where we might be able to quantify even more benefits of the technology for the industry.”

Lockheed Signals Change Is Coming With New CEO

- > NEW LEADER CHOSEN FROM OUTSIDE THE COMPANY'S RANKS
- > ANALYSTS SAY CEO-DESIGNATE MAY MEAN MORE COMMERCIAL WORK

Michael Bruno Washington

Lockheed Martin Chairman, CEO and President Marillyn Hewson became the prime example of how to stumble into the corner office of the Pentagon's top contractor and still provide laudable business results. Now, as she hands off the reins to an enigmatic successor, Lockheed stakeholders hope the uncertainty ahead will be just as lucrative.

On March 16, the Bethesda, Maryland-based prime—the largest contractor to the U.S. Defense Department by annual sales—surprised many followers with the news that current Lockheed board member James “Jim” Taiclet, Jr. will become CEO and president on June 15, while Hewson becomes executive chairman.

Lockheed also promoted Frank St. John, current executive vice president of the company's Rotary and Mission Systems (RMS) division, to become chief operating officer (COO)—a role that Hewson technically held last, and briefly, before her January 2013 appointment as chief executive. Before that, the COO role was mostly held by Chris Kubasik prior to his downfall at Lockheed. Stephanie Hill, now senior vice president for enterprise business transformation, was appointed to succeed St. John as executive vice president for RMS. These appointments also are effective June 15.

Hewson is 66 years old and Taiclet is 59. The company, which does not have a retirement rule, had not announced a formal transition plan or successor process. Nevertheless, industry insiders were watching movements—such as St. John's rise and recent board appointments—and analysts said they assume the transition was planned before the ongoing COVID-19 crisis erupted.

While the announcement was a surprise, the timing was not—due to Hewson's age and the fact that Lockheed ended 2019 with a record \$144 billion backlog of work and a stock price that has more than tripled under Hewson, including the recent COVID-19-related pullback. Still, many observers are intrigued by the selection.

“While Marillyn's retirement has been in the cards for a while, we were not expecting Lockheed to go outside the company for its new CEO,” say analysts at Vertical Research Partners. “Taiclet has an impressive pedigree based on his resume, but from an A&D perspective, he is an unknown quantity. . . . But with Marillyn sticking around as chairman, and a very experienced cohort of senior Lockheed managers, we are not expecting there to be

any revolutionary change as a result of this appointment.”

Cowen analysts also noted that St. John's appointment as COO further bookends Taiclet with experienced Lockheed managers. St. John, 53, joined Lockheed more than 30 years ago and as COO is naturally positioned as a potential future CEO, analysts say.

Taiclet is currently chairman, president and CEO of American Tower, a real estate investment holding company and owner/operator of wireless and broadband communications networks, where he has held the executive reins since 2003. He joined that company in 2001 and, according to Lockheed, is credited with guiding American Tower's transformation from a U.S.-centric focus to a multinational business outlook. Analysts said he also was central in leading mergers and acquisitions as part of the company's expansion. American Tower announced an immediate replacement for Taiclet but said he will remain chairman and an advisor through June 14.

Taiclet previously served as president of Honeywell Aerospace Services and before that was vice president for engine services at Pratt & Whitney of United Technologies (UTC).

He also worked as a consultant at McKinsey & Co., specializing in telecommunications and aerospace strategy and operations. He is a retired U.S. Air Force pilot and Persian Gulf War veteran.

Loren Thompson, a Lexington Institute consultant to Lockheed, says Hewson's selection of Taiclet seems calculated to continue her emphasis on tight financial management and good customer relations while positioning the leading prime for a changing demand environment.

“That environment will be characterized by two shifts from previous years,” Thompson writes. “First, the defense budget will enter a flat to declining period very different from the spending increases of the early Trump [administration] years.

Second, the preference of military customers for nontraditional suppliers who think like entrepreneurial enterprises rather than government contractors will continue to grow.”

Hewson's selection of Taiclet also is telling because she has won the respect of many industry insiders, analysts and advisers. While unplanned, Hewson's tenure as CEO was deemed successful by most.

“Hewson's tenure is known for operational execution with such programs as the F-35, while having a successful oversight in maintaining key businesses—such as in the evolving area of space with wins such as Next-Gen OPIR and GPS IIF,” say Jefferies analysts. Company sales grew at a 5% compound annual growth rate from \$45.4 billion in 2013 to an expected \$63.3 billion this year.

Taiclet's takeover sounds to many like more of the same—but different. “This is the first time Lockheed Martin has promoted someone who did not rise through the corporation to be president and CEO,” writes Capital Alpha Partners analyst Byron Callan. “We find it intriguing that he has a commercial background and wonder if that's not a different direction the company starts to explore in 2020-25.”



LOCKHEED MARTIN PHOTOS

Chairman, CEO and President Marillyn Hewson will become executive chairman only starting June 15, when James “Jim” Taiclet, Jr. will become the new CEO and president.

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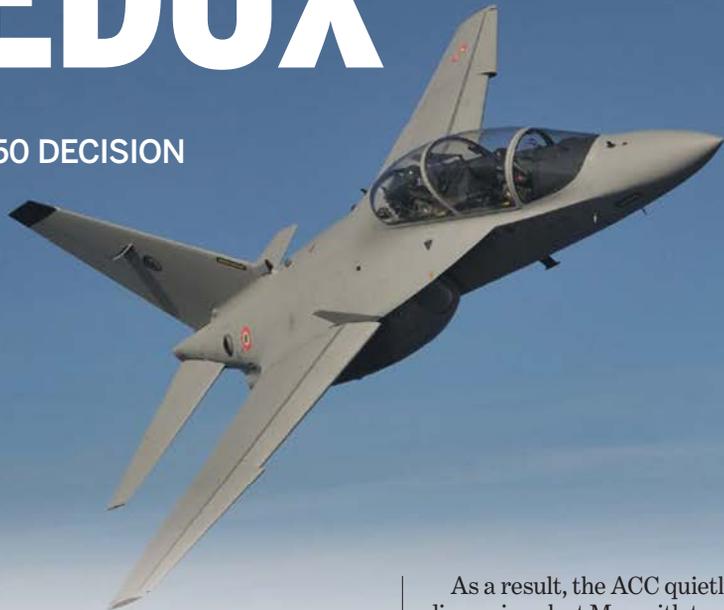
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T-X REDUX

> M-346 BIDDER DISPUTES T-50 DECISION

> RADAR REQUIREMENT
TILTS THE ACC TO T-50

> ACC SEEKING TO REVAMP
USAF PILOT TRAINING



Steve Trimble Washington

Two advanced jet trainers—Korea Aerospace Industries/Lockheed Martin's T-50 and Leonardo's M-346—dueled for decades for a chance to replace the U.S. Air Force's T-38 fleet, only to lose to the Boeing/Saab team's upstart and recently branded T-7A.

The T-X competition ended 18 months ago, but a quietly heated competition between the T-50 and the M-346 to land a new Air Force contract called the "RFX" continues.

To be sure, the Boeing/Saab team's grip on the \$9.2 billion T-X contract remains safe. The Air Force is still counting on Boeing to deliver potentially 351 T-7As, with the first aircraft and simulator scheduled to be delivered to Joint Base San Antonio-Randolph, Texas, in 2023.

Before the T-7A can arrive, however, head of Air Combat Command (ACC) Gen. Mike Holmes has defined a requirement for the RFX: It would consist of access to 4-8 advanced jet trainers, each rented annually for about 4,500 flight hours over a five-year period.

In an ironic twist, as a result of the RFX, one of the two losing aircraft for the T-X contract could play a pivotal role in transforming how the Air Force uses and bases the future T-7A fleet.

Holmes says the T-7A's modern capabilities offer a generational chance not just to replace the 60-year-old

Northrop T-38 fleet but also to revamp an 80-year-old pilot-training system that he says produces too few pilots and emphasizes the wrong skills.

Last year, Holmes unveiled an ACC-led plan to reshape the pipeline for fighter and bomber pilots. His "Project Reforge" with the RFX, originally published on the War on the Rocks online publication, proposes to eliminate Formal Training Units and mix advanced jet trainers such as the T-7A with frontline fighters in operational squadrons.

But first Holmes wants to validate that his ideas work. By renting flight time on advanced jet trainers available now, rather than waiting for T-7As after 2023, Holmes wants the ACC to be ready for a dramatic shift in training practices as the Boeing/Saab aircraft come into service. Thus, Holmes' timeline rules out using the T-7A for the validation phase. Boeing has produced only two industry-funded prototypes, and both are needed to support the T-7A development program, which is scheduled to end at the initial operational capability milestone in 2024.

As a result, the ACC quietly opened discussions last May with two competing private companies that now represent the T-50 and M-346 to select a bidder for the RFX.

Hillwood Aviation, a Perot company, proposed T-50s to the ACC for the RFX contract. Mission System Solutions (MSS), an aerospace engineering services firm, offered M-346s.

From the beginning, the Air Force's requirements strongly favored the T-50. The initial request for information (RFI) for the RFX released last May included a requirement for supersonic speed, which is a highly touted feature of the T-50 but eliminates the subsonic M-346.

The ACC released the first request for information about the RFX services contract in May 2019, but Arlington, Texas-based MSS was initially unaware of the proposal, says MSS CEO David Nichols.

MSS had played a key role in the Leonardo team's bid for the M-346-derived T-100 bid for the T-X contract, providing aircraft engineering services during the lengthy source selection process. Following Boeing's loss in the competition, MSS moved to secure access to at least four "white-tail" M-346s produced by Leonardo without a customer. In May 2019, MSS then proposed to offer those M-346s to the Air Education and Training Command (AETC) as a stopgap to cover a shortfall of T-38s until the T-7A became available, Nichols says.

M-346s carry the same Elbit Systems embedded training technology that will be installed on Boeing's T-7A fleet, and MSS believes that should make a requirement for active sensors on RFX redundant.



MISSION SUPPORT SYSTEMS

It was during a presentation about the stopgap proposal to AETC that MSS first learned about the ACC's RFI for the RFX, Nichols says.

After MSS proposed the M-346, the ACC's requirements changed. The ACC dropped the requirement for a supersonic aircraft, calling instead for an aircraft that can achieve a closing speed with another of the same type of aircraft at 1,100 kt. Two M-346s can achieve a closing speed of 1,400 kt., Nichols says, so subsonic speed was no longer a disqualifying factor for the ACC.

But the ACC later added a new requirement: The RFX aircraft must be ready to carry a radar. South Korea operates a version of the T-50 with the Israel Aerospace Industries EL/M-2022 radar, so that aircraft remains eligible for Project Reforge. Leonardo is still in the process of qualifying its Grifo radar on the M-346, Nichols says. But the radar integration for the M-346FA requires engineering changes that are not retrofittable to the white-tail aircraft available to MSS, Nichols says.

Based on the radar requirement, the ACC decided in January to disqualify all other aircraft except the T-50s offered by Hillwood Aviation, whose chairman is Michael Moseley, former head of the ACC and Air Force chief of staff.

"The T-50 provides the advanced displays, training systems and active radar needed for the RFX. The

M-346 variant provides advanced displays and training systems needed for the RFX but does not have an active radar at this time, and the timeline for incorporating one was unknown. Therefore, only the T-50 meets the basic requirements for the RFX," an ACC spokesperson explained to Aviation Week.

A representative for Hillwood Aviation declined to comment.

The ACC notified industry in January that it intends to award a sole-source contract to Hillwood Aviation's T-50s for the RFX requirement.

The late addition of the radar requirement for the RFX surprised and baffled MSS, Nichols says.

"The radar was just an attempt to justify a sole-source award to the T-50—that's the way it appeared," Nichols says. "[It was] the fact that they never talked to us to say, 'Do you guys have a radar?'"

Although the ACC says the radar integration schedule for the M-346 is "unknown," Nichols says that MSS offered to provide Grifo-equipped M-346s for the RFX within 12 months of contract signing.

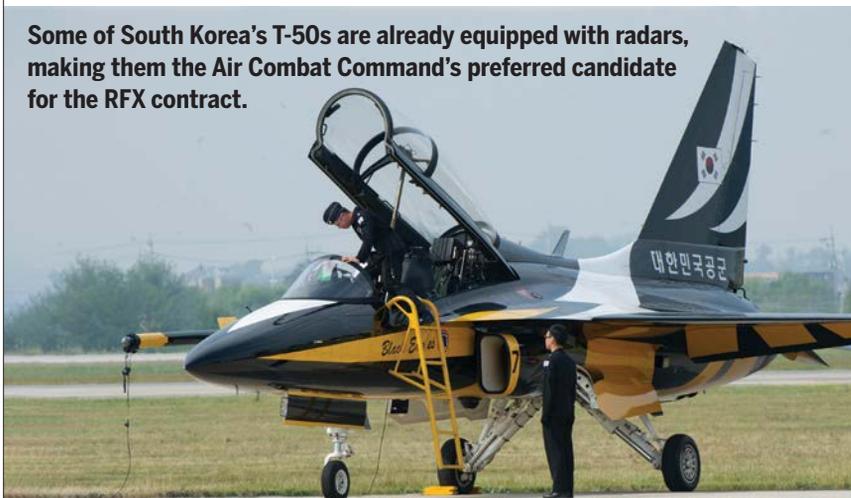
Nichols, an industry participant in the Air Force's search for a T-38

The ACC notified industry of the decision to award a sole-source contract to Hillwood Aviation in January but has taken no further action since then. In the interim, MSS has intensified its efforts to reverse the decision, enlisting congressional supporters to lobby the ACC and launching a media campaign focused on advertising the capabilities of the M-346 for the RFX requirement, Nichols says.

In order to win the award, MSS is seeking to pressure the ACC to drop the requirement for an active radar in the RFX fleet. In Nichols' view, the radar is unnecessary because the M-346's embedded training system is designed to emulate all of the sensors, including radars, on the Air Force's fleet of operational fighters. MSS' proposed M-346 aircraft comes equipped with Elbit's embedded training system, which Boeing also selected for the T-7A, Nichols says.

MSS' proposal is based on an agreement with a third-party financier, which will acquire the white-tails and provide them to MSS for the RFX, Nichols says. He declined to identify the financier. Once the five-year validation project is completed, MSS has an agreement with another operator

Some of South Korea's T-50s are already equipped with radars, making them the Air Combat Command's preferred candidate for the RFX contract.



U.S. AIR FORCE

replacement for a decade, suspects the original supersonic requirement for the RFX speaks to an internal desire within pockets of the ACC for a trainer with greater speed than the M-346 offers.

"You still have factions within the Air Force that are looking for a high-performance aircraft for a trainer aircraft, and the T-50 scratches that itch," Nichols says.

to continue using the aircraft, Nichols says. The aircraft can provide a broad range of services, including advanced pilot training and adversary air contract services, he says.

"We believe that there's a market" for the M-346 white-tails, Nichols says. "Whether it is doing pilot training, [adversary] air or supporting international air forces, we will find a way to keep our service going here in the States." ❁

As USAF Fleet Plans Evolve, Can the F-35A Program Survive Intact?

- > AIR FORCE WILL CONSIDER UAS TO REPLACE SOME F-16s
- > ACC SETS 60% GOAL FOR FIFTH-GEN MIX IN FIGHTER FLEET



Steve Trimble Washington

CYNTHIA GRIGGS/U.S. AIR FORCE

Original estimates for costs, schedules and quantities of the Lockheed Martin F-35 upon contract award in October 2001 proved highly unreliable over the fighter program's nearly two-decade life span, but one critical number did not: 1,763.

That four-digit figure represents program of record quantity for the U.S. Air Force—the F-35's largest customer by far—accounting for more than half of all projected orders by U.S. and international customers. The Navy and Marine Corps, the second- and third-largest buyers of the combat aircraft, respectively, downsized their planned F-35 fleet by 400 aircraft in 2004. But the Air Force's quantity never budged.

Although the Air Force's official number remains unchanged, the F-35A is facing a new credibility test after a series of public statements made by Gen. Mike Holmes, the head of Air Combat Command (ACC).

In late February, Holmes suggested that low-cost and attritable unmanned aircraft systems (UAS) might be considered by ACC as a replacement for F-16 Block 25/30 jets (also known as "pre-block F-16s") within 5-8 years. In congressional testimony on March 12, Holmes added that ACC's goal is to achieve a fighter fleet ratio of 60% fifth-generation jets, such as F-35As and F-22s, to 40% fourth-generation aircraft, including F-15s, F-16s and A-10s. He also said a recent analysis by the Office of the Secretary of Defense recommends an even split between fourth- and fifth-generation fighters.

Barring a significant increase in the Air Force's authorized force structure, both statements appear to jeopardize the mathematical possibility for the F-35A to achieve the full program of record.

As fleet acquisition plans stand today, the F-35A program of record appears sound. Lockheed has delivered at least 224 F-35As to the Air Force so far. The public program of record calls for the F-35A to replace A-10s and F-16s, which currently number 281 and 1,037, respectively, according to Aviation Week and Air Force databases. In 2010, Lockheed and F-35 Joint Program Office officials also confirmed that the F-35 would replace the F-15E fleet after 2035, which currently numbers 228 aircraft. Adding the number of F-35As already delivered, the Air Force has a replacement population of 1,770 aircraft.

But Holmes' statements could significantly alter the equation. The service's latest budget justification documents show about 325 of the 1,037 F-16s now in the Air Force fleet form the "pre-block" fleet that could be retired by attritable UAS instead of F-35As.

Holmes' goal of a fighter fleet with a 60% share of fifth-generation jets also complicates the forecast for the F-35A. Including the F-22 fleet's 186 aircraft, as well as 234 F-15C/Ds, the Air Force today operates a total fleet of 2,190 fighters. A 60% share of the fleet results in 1,314 total fifth-generation aircraft. After subtracting the numbers of F-22s, the Air Force would have room for only 1,128 F-35As, which implies a 34% reduction from the program of record of 1,763.

The U.S. Air Force's unbroken commitment to buy 1,763 F-35As through the mid-2040s appears threatened by new interest in low-cost UAS and fourth-generation fighters

The head of the Air Force's F-35 Integration Office acknowledges the numerical disparity implied by Holmes' statements, but he stands by the F-35 original program of record.

"The program of record for this aircraft is really long," Brig. Gen. David Abba said on March 9, referring to the Air Force's plans to continue F-35A production into the mid-2040s. "I understand that's a natural question to ask, but I don't think anybody's ready to make that sort of a declaration."

Altering the program of record would not change the steady, downward trajectory of the F-35A's recurring unit costs. Last year, Lockheed agreed to a priced option for Lot 14 deliveries in fiscal 2022, which falls to \$77.9 million. But changing the overall procurement quantity does have an impact on the program acquisition unit cost (PAUC), which calculates the average cost per aircraft, including recurring and nonrecurring costs. In the program of record, the PAUC estimate is currently \$116 million each for all three versions of the F-35.

Noting the forecast length of the F-35 production program, Abba recommends taking a long-term view.

"I would focus less on the program of record element," Abba said, and more on the Air Force's plans "to keep options open." 🗨️



TWENTIES

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MDA Seeks Two-Year Schedule Bump for New GBI Option

> PENTAGON SETS NGI DEBUT FOR 2028

> ENGINE TESTING SUGGESTS NORTH KOREAN THREAT ADVANCING

Steve Trimble Washington

Accelerated scheduling and exoatmospheric interceptor programs have a bleak track record over the past decade, but an impatient Pentagon leadership decided on March 10 to try it again.

The Next-Generation Interceptor (NGI) will enter service as early as 2028, or up to two years faster than the previous “end of the decade” timeline for the long-delayed follow-on and replacement for the 20-year-old Boeing Ground-Based Interceptor (GBI), several defense officials informed Congress during a series of hearing appearances in mid-March.

“We believe, based on [requests for information] received back from the contractors, that some significant shortening of that period is possible,” Defense Undersecretary Michael Griffin told a House Armed Services Committee panel on March 11.

Instead of immediately disqualifying bids that offer a faster delivery schedule at the expense of less performance, the MDA will ask combatant commanders if they are willing to accept that trade-off, said Vice Adm. Jon Hill, the Missile Defense Agency (MDA) director.

“We know we can have opportunities to pull in schedule [by] working with industry through the evaluation process,” Hill said. He added that the 2028 timeline is based on a 75% confidence level, versus the normal 50%.

Hill’s key operational partner, Northern Command head Gen. Terrence O’Shaughnessy, indicated he supports the new plan, which he helped decide during a Joint Requirements Oversight Council meeting at the Pentagon on March 10.

“We’re going to be able to bring this capability to bear sooner,” O’Shaughnessy testified to a third Armed Services panel on March 11.

Sitting alongside Hill during a hearing on March 12, O’Shaughnessy, whose command controls the 44 GBIs stationed in Alaska and California, also said he expects the MDA to deliver “follow-on” versions of the NGI

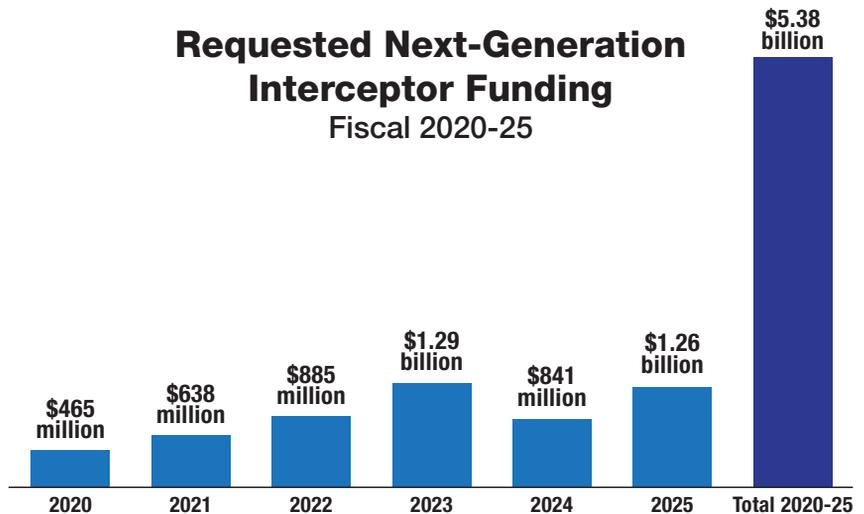
later—likely with improvements that address any performance gap for the accelerated deliveries in 2028.

The predictions received a bitterly skeptical response from one lawmaker. After listening to Griffin link the accelerated schedule to feedback from NGI bidders, Rep. James Cooper (D-Tenn.) shot back with an apparent reference to Boeing’s recent stumbles on testing NASA’s Starliner spacecraft. “But these are the same contractors who

But the administration of former President Barack Obama canceled a Multiple Kill Vehicle (MKV) upgrade for the GBI in 2009, only to revive the concept as the Multi-Object Kill Vehicle (MOKV) upgrade for the GBI in 2015. Two years later, the administration of President Donald Trump attempted to accelerate MOKV and deliver the upgrade five years earlier, in 2025, but congressional appropriators reallocated most of the funding as the MDA prioritized the Redesignated Kill Vehicle (RKV) upgrade for GBI. By early 2019, however, the RKV program had fallen two years behind schedule, leading Griffin to cancel the program in August 2019.

Meanwhile, the ICBM threat continues to evolve. The MDA’s charter is designed to ignore the threat of a volume attack by Russia and China, and instead

Requested Next-Generation Interceptor Funding Fiscal 2020-25



Source: U.S. Defense Department

failed to deliver us a space vehicle that could go to space,” Cooper said.

Other lawmakers are eager for the MDA to finally deliver a replacement for the GBI, which was rushed into service two decades ago before a full testing program. “We put a person on the Moon in a shorter period of time,” said Rep. Mike Turner (R-Ohio).

Indeed, the MDA has sought to replace or upgrade the original GBI for 12 years. Boeing designed each of the 44 GBIs to carry a single kill vehicle, and a successful intercept could require launching interceptors at the same target. Even relatively primitive intercontinental ballistic missiles (ICBMs) carry decoys and countermeasures. More advanced ICBMs could release multiple warheads.

focus on a limited nuclear ICBM strike by a rogue state. North Korea’s capabilities for a long-range, ballistic strike appeared primitive until 2017, when a string of apparently successful flight tests demonstrated a potential capacity to strike the U.S. West Coast. Although North Korea has stopped long-range missile tests, the country’s capabilities continue to improve, O’Shaughnessy told Congress, referencing comments by North Korean leader Kim Jong Un.

“While Kim did not specify what this new weapon would be, recent engine testing suggests North Korea may be prepared to flight-test an even more capable ICBM design that could enhance Kim’s ability to threaten our homeland during a crisis or conflict,” O’Shaughnessy said. 🗳️

Possible New 'Engine War' Recasts Pratt as Champion of Competition

> LEGAL RULING EXPECTED BY JULY FOR PRATT'S TWO PROTESTS

> USAF WARNS COMPETITION WOULD CAUSE 2-3-YEAR DELAY

Steve Trimble Washington

A jet engine maker is now pressuring the U.S. Defense Department to scrap a plan to award a sole-source contract to a rival for a fleet of new fighters and investigate the opportunity for performance and cost improvements yielded by a competitive selection process.

If that narrative sounds familiar, it is because it echoes a role GE Aviation played for more than 40 years, which included a successful bid in the 1980s to launch the "Great Engine War" over the F-15 and F-16 fleets, and a failed campaign that ended almost a decade ago to establish the F136 as the alternate engine for the F-35.

This time, however, the roles are reversed. Pratt & Whitney,

Pratt & Whitney's F100 (pictured) is designed to be interchangeable with GE Aviation's F110 as the engine for the Boeing F-15 fleet.

which waged fierce lobbying campaigns against competitive engine policies for the F-15, F-16 and F-35, has switched sides in the debate.

In response to the U.S. Air Force's decision to field the F-15EX into production powered solely by GE F110 engines, Pratt has filed two protests with the Government Accountability Office (GAO), which is scheduled to render judgments on both cases by early July.

The Air Force sided with GE during the Great Engine War in 1984. Seeking to lower costs and motivate Pratt to resolve stall-stagnation problems with the original F100, the Air Force decided that year to split the engine contract for the F-15 and F-16 between GE's F110 and Pratt's F100.

Thirty-six years later, the Air Force now worries about the schedule impact if the GAO sustains either or both of Pratt's protests for the F-15EX

engine. Service officials decided to acquire the F-15EX after concluding the F-15C/Ds were too costly to sustain and partly because it would take too long for the Pratt F135-powered F-35A to replace all of them.

Pratt's protests now threaten to disrupt that schedule and erode the Air Force's original business case for the F-15EX.

"If we have to do an engine competition, it will add time—2-3 years," said Will Roper, assistant secretary of the Air Force for Acquisition,



STAFF SGT. THOMAS TROWER/U.S. AIR FORCE

Technology and Logistics, testifying before the House Armed Services Committee on March 10.

Only a decade ago, Pratt welcomed a vote by Congress in 2010 to cancel funding for the F-35 program's alternate engine, along with a decision by GE and Rolls-Royce a year later to abandon a plan to self-fund the certification of the F136. But Pratt now embraces the potential benefits of an engine competition for the F-15EX.

"Our government supports competition at all levels, and we're interested in providing the F100 as a competitive

alternative," Pratt Military Engines President Matthew Bromberg told Aviation Week. "If we're not competitive in terms of capability, schedule [and] price, I get it. But after the U.S. government spent all this money creating two engines for the F-15 and F-16 platforms, why would it then not compete a 450-engine program?"

Asked if the existing F100 would require additional development to meet the Air Force's requirements for the F-15EX, Bromberg replied that he cannot answer that question in the absence of a competitive process that allows Pratt access to the specifications. He also noted that the F100 exclusively powers the Air Force's existing fleet of F-15Es.

The F100 and F110 were designed to fit interchangeably in the F-15, although the heavily modified Saudi Arabian F-15SA and the Qatari F-15QA from which the F-15EX was derived are

exclusively powered by GE's engine.

The GAO does not release complaints filed by protesters up front, but it does release the full text of decisions. It is not clear why Pratt filed two separate protests on the sole-source decision for the GE engine on the F-15EX, but Bromberg advised not reading too much into it.

"I'd like to obviously be able to discuss them, but I can't because it's a legal process," Bromberg said. "I would really view them as a single protest on a single procurement action, and that is a lack of competition." ❁

Marines Dial Back UAS Strategy

> MUX PLAGUED BY REQUIREMENTS CREEP

> MARINES OPT FOR FAMILY-OF-SYSTEMS APPROACH

Lee Hudson Washington

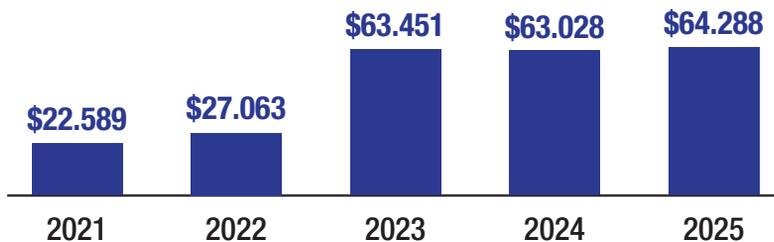
The U.S. Marine Corps is drastically changing course in its effort to develop a large unmanned aircraft for vertical takeoff from amphibious ships. Instead of a single large, expensive air vehicle that can do everything, the service plans to buy smaller unmanned systems for specific missions.

The Marine Air-Ground Task Force Unmanned Aircraft Expeditionary (MUX) effort was initially envisioned as a Group 5 shipboard unmanned aircraft system (UAS) that could conduct high-end mission profiles. The Pen-

ditionary Force's capability gaps. The next-generation UAS is intended to have greater range, endurance, altitude and payload capability than conventional vertical-takeoff-and-landing technology.

"With a family-of-systems approach, my sense is we're going to have an air vehicle that can do some of the higher-end requirements from a land-based, high-endurance vehicle, but we're still going to maintain a shipboard capability; it may just not be as big as we originally configured," Rudder says.

Marine Corps MUX MALE Group 5 UAV
(Fiscal 2021-25, U.S. millions)



Source: U.S. Navy fiscal 2021 budget request

tagon is facing a stagnating budget topline, and the service's reshaping of its new UAS program is a casualty.

The head of the Marine Corps points to MUX as an example of requirements creep and how the services must be more disciplined. The Marines piled on 15 requirements for MUX and caused the program to become buried and unmanageable, says Marine Corps Commandant Gen. David Berger.

"Now we're [going] the other way, shrinking back down," Berger says.

The Marine Corps is altering its strategy by not having a long list of critical requirements for a single air vehicle, says Lt. Gen. Steven Rudder, deputy commandant for aviation. The top requirement is airborne early warning coverage for amphibious forces. The U.S. Military Strategy and the U.S. Maritime Strategy require an advanced, multimission ship-based Group 5 UAS to fill the Marine Expe-

The service operates the Boeing Insitu RQ-21 Blackjack to fulfill its shipboard intelligence, surveillance and reconnaissance (ISR) requirements. Rudder envisions the MUX shipboard capability to be "RQ-21+" or some sort of Group 3 or 4 air vehicle.

The Marine Corps is still holding out hope for a Group 5 UAS, but that will not be possible until far into the future, Rudder says. The service imagines there will be one air vehicle in the near term that is land-based, and a separate shipboard design.

Berger wants MUX to come into fruition within the next 10 years, and the Marine Corps believes the quickest way to make it happen is by purchasing a land-based high-endurance air vehicle and a separate UAS that can operate from an amphibious ship.

There is no plan for the Marine Corps to use the Navy's Boeing MQ-25 Stingray for its shipboard UAS role

because the air vehicle is designed for an aircraft carrier, not an amphibious assault ship. The MQ-25 requires a catapult shot and an arresting cable—and this launch-and-recovery method is not available on an amphibious ship.

The Marines operate General Atomics MQ-9 Reapers from MCAS Yuma in Arizona to support Task Force Southwest in Afghanistan. This capability is intended to inform concepts of operations for MUX and is allowing the service to nurture its own cadre of UAS operators.

The service flipped the script when creating a development to acquire the next-generation UAS. Traditionally, the Marines would have launched a competition to purchase a new Group 5 UAS. Instead the Marine Corps kicked off a competition to figure out what payloads it wants developed before purchasing an air vehicle. In November, the Navy awarded contracts for the creation of four individual mission payloads: airborne early warning, data relay, electronic warfare and ISR.

Each first-place winner received \$700,000. Second-place winners received \$200,000, and third-place finishers received \$100,000.

Boeing won first place for the data relay payload design concept, and BAE Systems took the top spot for the ISR prize challenge. Telephonics secured first place with its design concept for an airborne early warning mission payload, and L3Harris Technologies won first place for the electronic warfare mission payload.

Piasecki Aircraft Corp. took second place for the airborne early warning mission payload, and Bell Textron/Sierra Nevada won third place. Piasecki also came in second for the ISR mission payload, while General Atomics secured third place.

Northrop Grumman finished in second place for the data relay mission payload, and Cubic Defense Applications Inc. came in third. General Atomics won second place in the electronic warfare payload category, and Piasecki came in third.

In December, the Marine Corps canceled prize challenges for architecture and modularity and instead opted for a government-driven approach.

Current Marine Corps plans are for MUX to be introduced into the fleet in 2026, flying ahead of Lockheed Martin F-35s and Bell-Boeing V-22s to perform support tasks. ☛

U.S. Army Pushes Ahead With Black Hawk Replacement Program

> DEMONSTRATION, RISK-REDUCTION PHASE SPANS FISCAL 2022

> UH-60 REPLACEMENT ACCELERATED BY FOUR YEARS

Lee Hudson Washington

Over the next two years, two teams, Sikorsky-Boeing and Bell, will continue risk-reduction work for the U.S. Army's effort to replace the aging UH-60 Black Hawk.

The service awarded Sikorsky-Boeing \$97 million and Bell \$84 million for project agreements under the Aviation and Missile Technology Consortium's Other Transaction Authority. The companies will deliver initial conceptual designs, requirements feasibility and trade studies over two years, before a formal program of record begins.

A \$7 million difference exists in the project agreements, because al-

though the scope of each proposal was similar, the companies have different technical and costing approaches, says Col. David Phillips, project manager of Future Long-Range Assault Aircraft (FLRAA). Bell built the V-280 Valor, which reached 300 kt., while Sikorsky-Boeing constructed the SB-1 Defiant to reach at least 250 kt.

The Valor has flown 170 hr. in flight testing and presented to the Army

even though there was no flight time associated with that . . . a tremendous amount of data came out of that," says Brig. Gen. Walter Rugen, Future Vertical Lift cross-functional team director. "The flight envelope continues to expand for Sikorsky-Boeing. They're flying a bit more aggressively now than the V-280, and as the JMR finishes up toward the end of this fiscal year, maybe August, we're going to see very comparable data on both sides."

Not every single hour of flight time is valuable for the Army. It depends on what test points were executed during each flight. The same goes for mod-

The SB-1 Defiant is designed to reach speeds of at least 250 kt.



Bell's V-280 Valor demonstrator has already flown at 300 kt.

BELL

eling and simulation: The Army puts more weight into what was tested, says Patrick Mason, program executive officer for aviation.

A Defense Department independent review of FLRAA's technology readiness level (TRL) decided most areas were a TRL 6 or 7, while some were rated a 5, Rugen says. This resulted in the Army's decision to conduct the two-year competitive demonstration and risk-reduction phase to raise TRLs to between 7 and 9 before entering a program of record.

"We see this as a good competition between two vendors that are moving forward and executing what we need them to do," Mason says.

Rugen echoes this sentiment. "The proof is in the pudding," he says. The Army accelerated FLRAA by four years in the fiscal year 2021 budget request.

The service intends to make FLRAA a program of record in fiscal year 2022. At that point, other vendors could enter the competition and bid on follow-on efforts. ☐

though the scope of each proposal was similar, the companies have different technical and costing approaches, says Col. David Phillips, project manager of Future Long-Range Assault Aircraft (FLRAA).

Two advanced rotorcraft were manufactured for the Army's Joint Multi-Role (JMR) technology demonstration,

the data that Bell captured over more than two years. During development, the Valor logged more flight time than the Defiant; however, the Army was comfortable enough with the amount of data the Sikorsky-Boeing team submitted to award a project agreement.

"With the iron bird approach that Sikorsky-Boeing went forward with,

LOCKHEED MARTIN



Korean Air Designs Stealth Drone Demonstrator

> REPUBLIC OF KOREA AIR FORCE WANTS A RECONNAISSANCE VERSION FIRST

> ENGINE WORK IS UNDERWAY, BUT MAYBE NOT FOR THIS AIRCRAFT

Bradley Perrett and **Kim Minseok** Seoul

Nine years ago, the Republic of Korea Air Force hoped to have an unmanned combat aircraft in service by 2030. If funding becomes available soon, it could have at least a stealthy reconnaissance and surveillance drone ready by then, according to officials close to a Korean Air program for such an aircraft.

initially for surveillance and reconnaissance versions only, according to other sources who are familiar with defense planning. Engineering a drone for weapon delivery would be much harder.

Korean Air proposes a considerable aircraft, obviously designed for controlling radar reflections. The wing-

strator, the Kaori-X, in 2015. This dealt with some of the larger developmental challenges, especially control in flight and fast taxiing, the sources say.

Korean Air displayed a model of the KUS-FC at the Seoul Aerospace and Defense Exhibition in October 2019. But the model was the same one that the company had showed at the exhibition in 2011, when the concept was called KUS-X. That was when the air force said it wanted to bring a strike drone into service in 2030; it was envisaged as a first-tier aircraft, alongside the Lockheed Martin F-35 Lightning and Boeing F-15K, while the Korea Aerospace Industries KF-X and FA-50 filled the next two tiers.

Getting the drone ready by then is still achievable if the ministry soon



This model of Korean Air's stealthy drone proposal was first displayed in 2011 and probably no longer represents the intended design.

BRADLEY PERRETT/AW&ST

The company is preparing a design for a full-scale technology demonstrator for the proposed type. But the program lacks funding for flight testing, according to one of several sources who discussed it with Aviation Week. It is run by the defense ministry's Agency for Defense Development (ADD), which is undertaking much of the related technology effort.

The Republic of Korea Air Force wants to operate such an aircraft. The Korean Air design includes a weapon bay, but the air force is looking

span of the blended-wing-body design, KUS-FC, is 16 m (53 ft.) and the length is 10 m. The X-47B technology demonstrator that Northrop Grumman built for the U.S. had a span of 18.9 m.

A parallel program is working on engines for unmanned aircraft. But the prospective timing of KUS-FC development and the size of the aircraft raises doubts that it could use an indigenous powerplant.

Endurance for the KUS-FC is intended to be 6 hr.

The ADD flew a subscale demon-

strator, the Kaori-X, in 2015. This dealt with some of the larger developmental challenges, especially control in flight and fast taxiing, the sources say. According to them, several missions are being considered for the aircraft, not including air combat.

The current design, on which Korean Air began work in 2016, is probably rather different to that depicted by the mockup. In 2016 ADD published a design with greater wing chord than the Kaori-X and the mockup.

At that time, the agency was planning to build a mockup with a 15-m span—for testing of radar cross-section

tions—and eight subscale test aircraft with spans of 3 m. Progress with the little test aircraft is unknown, but the sources say no money is available yet to build and fly the full-scale design.

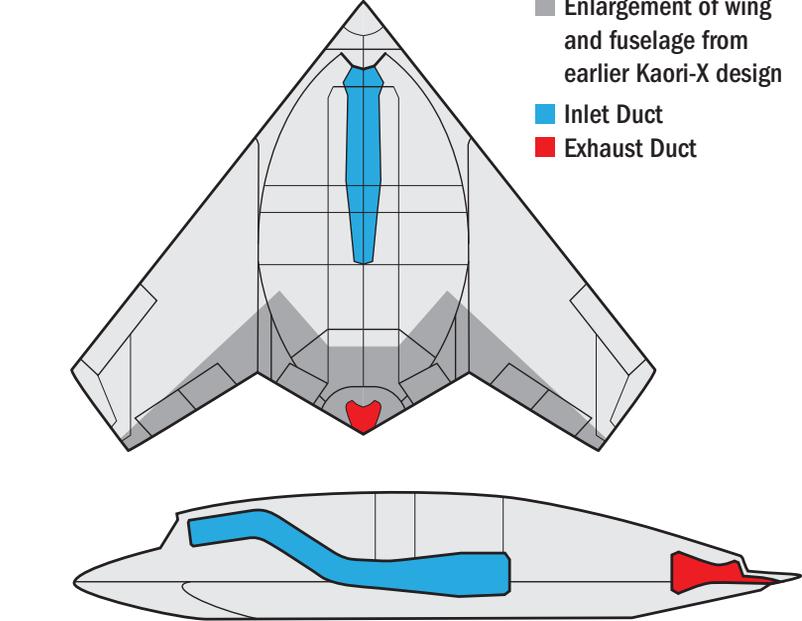
In Korean Air's design, the airframe consists of carbon-fiber-reinforced plastic over an aluminum substructure. The exact choice of materials is still subject to review, one source says.

Research and development is being done at the South Korean city of Daejeon, where the ADD is based. Production would be undertaken at Korean Air's factory near Busan. A production rate of two aircraft per month is proposed.

The cost of building and testing a full-scale demonstrator would be much less than \$100 million, the sources say, noting that the equivalent phase of the Korean Air MUAV drone project did not cost nearly as much as that. The MUAV is a medium-altitude, long-endurance surveillance aircraft. With a straight, slim wing, it hardly provided all the knowledge for flight control the ADD and Korean Air need for a swept blended-wing-body jet.

One particular issue undertaken with the Kaori-X was to ensure that the aircraft did not flip over on its back when running fast on the ground, one source says.

Meanwhile, work on engine research and development is stepping up. The ministry's Defense Acquisition Program Administration (DAPA)



ADD's preliminary design published in 2016.

SOURCE: AGENCY FOR DEFENSE DEVELOPMENT. ILLUSTRATION: COLIN THROM/AW&ST

established a research center for gas-turbine engines for drones in December 2018. The title indicates that its scope of work could include turboprops, turbojets and turboprops.

In January, DAPA and ADD named Hanwha Aerospace as prime contractor for a UAV turboprop development project, news agency News1 reported. The budget up to 2025 is 88 billion won (\$74 million), which looks like

enough for only exploratory work.

The X-47B used the Pratt & Whitney F100-PW-220U, a nonafterburning version of a powerful fighter engine. It generated 16,000-lb. thrust. For equal flight performance, the KUS-FC would probably need around 10,000-lb. thrust—again, without afterburning. No South Korean program for an engine of anything like that size is known. 🇰🇷

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Post-Brexit Defense Review Challenged by Costs and Coronavirus

> UK MINISTERS WANT TO COMPLETE THE REVIEW WITHIN MONTHS

> EQUIPMENT PLANS ARE STILL CHALLENGED BY BUDGET DEFICITS

Tony Osborne London

Post-Brexit Britain is taking its first steps toward understanding its place in the world and the military capabilities it may need to ensure it can hold onto that status.

A review, described by Prime Minister Boris Johnson as the most extensive of its kind since the end of the Cold War, is examining the UK's foreign, defense, security and development policies. And it is proceeding despite the challenges and costs surrounding the COVID-19 pandemic.

Although it will examine the work of several government departments—

notably the Foreign Office, the Defense Ministry and the Department for International Development—considerable focus is likely to be on defense. It has the largest budget of those under the microscope and an oft-criticized procurement process that some in government are eager to overhaul.

The process will run in parallel with the government's comprehensive spending review. That assessment decides UK government spending for the next three years and will deliver its findings potentially as early as this summer. Some critics argue that is

simply too soon for a thorough analysis of Britain's future defense needs.

"If you are to have a strategy that is worth the name, you must address ends, ways and means together. . . . If you do not do the whole package, including the money, together, then you do not have a strategic review," Jock Stirrup, a former chief of the Royal Air Force (RAF) and UK Defense Staff, told parliamentary defense committee hearings on March 17.

The 2020 review represents a break from the traditional defense-led Strategic Defense and Security Review (SDSR) usually held every five years. Some analysts contend the 2020 edition could shape defense capabilities for decades to come. Jack Watling, Land Warfare research fellow at the London-based Royal United Services Institute (RUSI) says the review would have to make "hard choices" but that these would "determine the trajectory of the UK's defense capabilities for a generation."

**Britain is committed to 138 F-35s
but has yet to budget for 90 of them.**



SAC AMY LUPTON/ROYAL AIR FORCE

He notes that for a post-Brexit Britain looking to expand its trading and security partners, future conflicts may be difficult to avoid. "Security and trade partnerships are closely intertwined. . . . If 'Global Britain' means diversifying our economic partnerships, it will be necessary to build meaningful security ties as well," Watling says.

The UK must look at its role in the Euro-Atlantic alliance and in the Great Power competition, in addition to other global issues and homeland security, Defense Minister Ben Wallace told Parliament. The review will also "place prosperity and manufacturing at its heart," he added.

The assessment comes at a challenging time for Britain's defense and its equipment-procurement plans. The National Audit Office recently warned that for a third consecutive year there will be shortfalls in the budget. The ministry's plans call for the spending of £183.6 billion (\$214 bil-

lion) over the next 10 years, equivalent to 42% of the ministry budget during that period. Auditors say the Defense Ministry has a shortfall of at least £2.9 billion over that period, but this could be as high as £13 billion.

Although the UK is expanding its intelligence, surveillance and reconnaissance (ISR) capabilities with the upcoming arrival of the General Atomics Protector unmanned aircraft system and deliveries of the Boeing P-8 Poseidon maritime patroller—two of which have already arrived—capability gaps in the ISR mission are imminent.

The planned retirement of the RAF's long-suffering Boeing E-3D Sentry fleet has been pushed to December 2022. But the Boeing E-7 Wedgetail, the 737-based platform planned as its replacement, is not due to enter service until the end of 2023, potentially leaving a yearlong capability gap. The RAF also plans to retire its Raytheon Sentinel radar-reconnaissance platform in March 2021. It got several reprieves after its Afghanistan duties ended, but its departure would leave the UK without a standoff ground-moving-target-indicator and synthetic aperture radar platform.

Several commitments made in the 2015 SDSR, such as the UK's decision to commit all 138 Lockheed Martin F-35 Joint Strike Fighters across the lifetime of the program, have also not been budgeted, auditors note. Current plans forecast only the costs of the first 48 aircraft. The government says that "decisions on future numbers and aircraft variants will be taken at the relevant time," but it is unclear whether this will be considered in the review.

The British government is aiming to maintain the target of 2% of GDP set by NATO for all allies. Defense ministers have said they will fight to meet that share, and more if needed, although the UK has a history of not fully funding post-review defense portfolios. "It is not a review designed to cut costs," says Jeremy Quin, minister for defense procurement. "It is a review designed to ensure we know what we are doing in the world and that [this is achieved] through really effective equipment."

Along with defining capabilities required for land, sea and air, the review is also likely to conclude that the UK should make additional investment in both the cyber and space domains. 🌐



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DEFENSE AIRCRAFT OPPORTUNITIES IN SOUTH AMERICA

Across South America, militaries have ongoing requirements for fighters, attack helicopters and surveillance aircraft. Here is a snapshot of some of the **outstanding requirements that could translate into new acquisitions** over the course of the 2020s, according to the Aviation Week Intelligence Network.

Daniel Urchick and **Matt Joupi** Washington



GOVERNMENT OF ARGENTINA

PARAGUAY

The **Paraguayan Air Force** is seeking to replace its EMB-312A Tucano aircraft with a fleet of six light combat aircraft. Officials from the service observed the U.S. Air Force's OA-X trials in 2017 between the Embraer A-29 and Textron AT-6. Argentina's Fabrica Militar de Aviones (FMA) is also offering its IA-63 Pampa to fill the requirement.



DASSAULT

PERU

Peru began studying its requirement for fighter aircraft in 2018 and is still looking to replace its air force's Dassault Mirage 2000 and Mikoyan MiG-29 fleets with a single type of aircraft. Contending for the role are the Dassault Rafale, Korea Aerospace Industries FA-50, Lockheed Martin F-16 and Mikoyan MiG-35.

The country is also considering the purchase of an airborne early warning and control aircraft, either the Embraer 145 or Saab 340 as part of its effort to modernize through 2025. And it is seeking a dozen light utility helicopters to conduct search-and-rescue missions.

COLOMBIA

In July 2019, the **Colombian Air Force** short-listed three teams in its quest to replace a fleet of Israel Aerospace Industries Kfir fighters. Seeking 18 aircraft when funds are available, Colombia will turn to the Eurofighter Typhoon, Lockheed Martin's F-16 Block 70/72 or the Saab JAS 39.

The **Colombian Navy** wants to expand its maritime surveillance fleet of three Airbus CN-235 maritime



CHILE

The **Chilean Air Force** plans to retire its Boeing EB-707 Phalcon around 2025. Last year, officials from Saab met with senior service officials to discuss further requirements for airborne early warning and control aircraft. The service has a requirement for one such aircraft and is



LOCKHEED MARTIN



TONY OSBORNE/AW&ST

BRAZIL

The **Brazilian Army** has a strategic program for aviation revealing its desire to acquire a new attack helicopter by 2021, and the **Navy** may partner on the purchase. A number of companies are contending for the chance at making 12 aircraft for each service, including the Airbus Tiger, Bell AH-1Z Viper, the Boeing AH-64E Apache and the Turkish Aerospace Industries T129 ATAK.

patrollers with four new aircraft. It may opt to continue with the CN-235 or pick up the ATR 42-300 or the Beechcraft B350i.

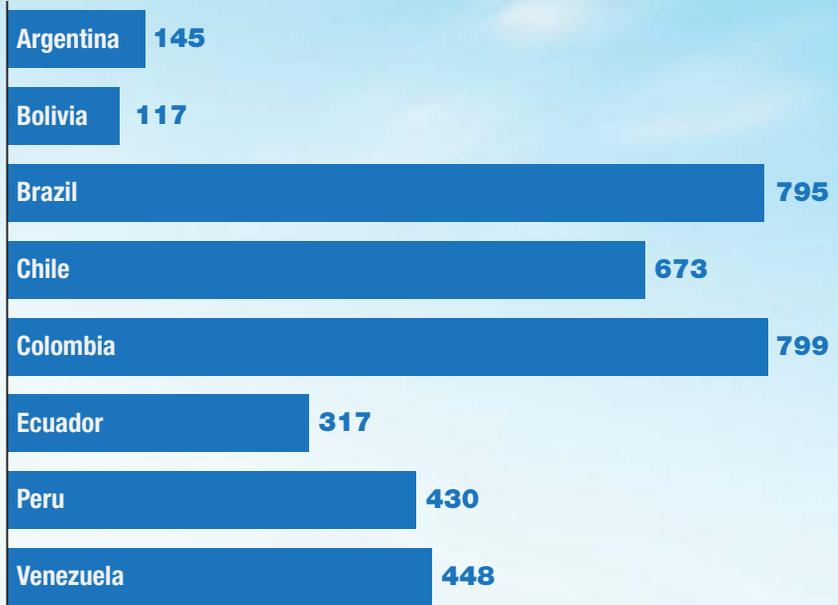
\$520 MILLION

The amount of **Brazilian aircraft exports** in 2009-19, according to the Stockholm International Peace Research Institute.



SAAB

South American Military Aircraft Imports 2009-19 (in U.S. \$ millions)



reportedly considering the Saab GlobalEye and the China Electronics Technology Group Corp. Y-9.

The **Chilean Army** expects to order six light-to-medium tactical transport aircraft around 2021. The primary contenders are the Airbus C295 and the Leonardo C-27J.

Source: Stockholm International Peace Research Institute

NASA Planning Electrified Propulsion Flight Demonstrations

- > FIVE CONTRACTORS ARE DETAILING DEMONSTRATION PROPOSALS
- > THE PROJECT WOULD BUILD ON PLANNED INDUSTRY TESTBEDS



Guy Norris Los Angeles and **Graham Warwick** Washington

Acknowledging the rapid evolution of the electric aircraft market, NASA wants to tap into industry plans for electrified power-train demonstrators to advance toward its ultimate goal of applying the technology to single-aisle airliners.

NASA is planning an Electrified Powertrain Flight Demonstration (EPFD) project that would build on component technology work now underway, take advantage of power-train demonstrators already planned by industry and lead to a possible “multi-technology” subsonic X-plane. A follow-on to NASA’s X-59 QueSST low-boom supersonic flight demonstrator, this could combine electrified propulsion with an unconventional configuration for an ultraefficient airliner.

Planned to begin in fiscal 2021, the EPFD would prove technology for electrified propulsion in the 1-megawatt power range, for aircraft entering service in 2030-35. NASA believes electrified propulsion could reduce both total energy and maintenance costs for future commercial aircraft.

As a first step, NASA awarded five Electric Aircraft Propulsion (EAP) contracts to manufacturers for project planning and risk reduction. “All are focused on future flight demonstrations to be executed under EPFD,” says Fay Collier, associate director for flight strategy in NASA’s Integrated Aviation Systems Program.

Initial contracts awarded to Boeing, General Electric and Pratt & Whitney

in June 2019 will be completed this June. NASA also let EAP contracts to startups Ampaire and Wright Electric in September 2019 that will be completed this September. Contractors were assigned 12 tasks, including outlining plans for a flying testbed under the EPFD.

NASA’s notional timeline for electrified power-train development begins with the technology maturation already underway, progresses through ground and flight tests of turboprop-focused demonstrators to turbofan-focused testbeds and culminates in a “multi-tech” X-plane aimed at an eventual electrified single-aisle airliner.

Ampaire is flying a hybrid-electric demonstrator based on the Cessna 337 Skymaster, which it plans to certify as the 4-6-seat Electric EEL. Under its EAP contract with NASA, Ampaire is working with Ikhana Aircraft Services to study modifying the 19-seat de Havilland Canada DHC-6 Twin Otter to parallel hybrid-electric propulsion.

Wright is ground-testing a nine-seat aircraft modified to hybrid-electric propulsion and aimed at the private aviation market. It has also launched development of a 1.5-megawatt, 3-kilovolt power train as the foundation of the propulsion system for a 186-seat short-haul electric airliner aimed at entry into service around 2030.

Boeing is exploring electric propulsion at a small scale through urban air mobility programs with multiple subsidiaries and partners. GE Aviation has

tested a 1-megawatt motor and demonstrated 1 megawatt of dual-spool power extraction from an F110 fighter engine.

GE Research Center is now developing a flight-ready 1-megawatt DC-to-AC inverter using silicon carbide power electronics under a \$12 million collaboration with NASA. This will be tested at simulated 30,000-ft. altitude in the NASA Electric Aircraft Testbed facility at Plum Brook Station, Ohio.

Ampaire has converted a pair of Cessna 337 Skymasters to hybrid-electric propulsion testbeds.

Pratt has kept quiet about its NASA project work but is likely studying integration of a megawatt-class motor/generator into a second-generation geared turbofan optimized for more electric aircraft. Under Project 804, Collins Aerospace and Pratt & Whitney Canada are designing a parallel hybrid-electric demonstrator based on a de Havilland Canada Dash 8.

“We are asking [the contractors] what it will take to mature a 1-megawatt-class power train. What are the ground and flight tests that will be needed?” says Collier. “Then we are focusing on the flight-test vehicle itself. And we’ve asked each of them to describe the technical plan and risks associated with the flight test, the cost and the schedule.”

NASA is beginning with turbo-prop-focused electrified propulsion “because there are a lot of demonstrators on the drawing board, and people are starting to execute,” he says. “We’re moving toward a turbo-prop-based demonstration because it’s a great learning tool. It’s a good place to start. Using a turboprop testbed will be applicable to future larger applications as well.”

The path to turbofan-focused electrified propulsion is less clear. “[But] we are doing all this to ensure this technology suite will eventually impact the turbofan OEMs,” says Collier. “We believe all the learning that comes from simple and not-so-simple turboprop demonstrations will lead to good understanding.” He cites knowledge on integration with the aircraft and the cockpit, where batteries are located and cables run.

“A lot of the integration issues will be worked as we focus on the power train,” says Collier. “Keep in mind that we are very focused on power-train demon-

stration. With this new project it's not about anybody's favorite [aircraft] configuration for that technology."

NASA's next step is project formulation for a five-year EPFD effort beginning in October, assuming Congress approves the agency's fiscal 2021 budget request. Funded under a preformulation effort, the five EAP contracts call for details of each company's proposed testbed. "I gave each of them a chance to describe a couple of fairly low-level risk-reduction paths that they would want to take toward a flight demonstrator, and they're all different," Collier says.

Examples of questions to be answered are: "What are the human system integration issues associated with the testbed? If you're in the cockpit, how will you control this thing?" he says. "How is it going to be integrated with tests that help people working on the ground around the airplane or in the airplane? We also want to make sure that we have safe

ing," says Collier. "The bigger the airplane gets, the harder it's going to be and the longer it's going to take." The focus on 1 megawatt represents "the sweet spot," he says. "You can work up or down in size from there and make quite a bit of impact. So it's low-hanging fruit, and you can get a quick start."

A megawatt-class electric motor is four times the state of the art in power terms. "That is no small thing," says Collier. "A megawatt will enable electric propulsion to move from small to large. We can start small with thin-haul and regional aircraft, and these small projects will ultimately impact single-aisles, where NASA traditionally focuses."

This also means "we don't have to wait for 20-megawatt capability. How are we going to do this with a single-aisle replacement airplane that needs that much power? That's not going to happen for a long, long time," says Collier. "Hopefully, we can kick-start this thing so we can get something done

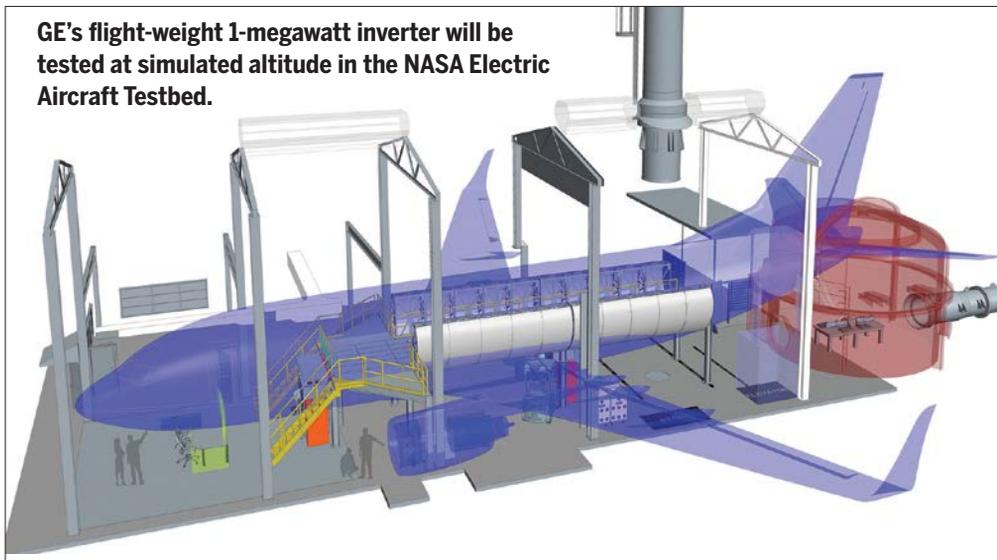
plan for what comes after the X-59 supersonic demonstrator. Four years ago, NASA envisaged an Ultra-Efficient Subsonic Technology (UEST) X-plane, proposals for which were dominated by blended wing-body (BWB) designs from Boeing, Dzyne Technologies and Lockheed Martin.

But NASA's subsonic project was subsequently redirected away from BWBs to focus more on hybrid-electric and all-electric concepts, and the agency sees the EPFD as an opportunity to springboard into a broader, more comprehensive follow-on X-plane with a significantly recrafted UEST effort. "We're still trying to define what would effectively be a 'multi-tech' airframe and propulsion demonstrator. And this electrified propulsion thing we're doing right now could fit right into that," Collier says.

The revised approach is also more holistic, says Jimmy Kenyon, director of NASA's Advanced Air Vehicles Program. "We're looking at a combination

of flight testing through the demonstrators as well as ground testing in our facilities at NASA or with some of our partners to understand how to mature the architectures and the individual components. A very important part of that is understanding the interaction effects in an appropriate environment."

"Right now, we're looking at how to make the best use of what's going on around the country with different industry partners and how to reduce the



GE's flight-weight 1-megawatt inverter will be tested at simulated altitude in the NASA Electric Aircraft Testbed.

operation of the flying testbed."

NASA is also exploring the option of a government-furnished "common" flying testbed that could be either owned and operated by industry or flown as a NASA-operated asset. The EAP contractors have been asked to describe their requirements for such a common testbed as well as the pros and cons of using this approach versus providing their own vehicles.

As early applications of electrified propulsion are likely to be smaller in size, "the smaller guys are going to have the advantage in terms of tim-

that's meaningful, and maybe accelerates progress toward larger systems."

Bob Pearce, NASA associate administrator for aeronautics, says the strategy of focusing on the 1-megawatt class builds on component and system work already underway within the agency. "The systems, motors and so forth tested so far are maybe not at the flight weights we would like to get to, but are significantly more advanced than what you can get commercially off the shelf."

A key consideration for the EPFD is how electrified propulsion technology might fold into NASA's evolving

risk relative to making a decision on how we could go forward with a vehicle that would demonstrate either an all-electric or hybrid-electric aircraft," says Ed Waggoner, deputy associate administrator for programs. "To do that, we're going to take advantage of assets that maybe industry already has in place and partner with them to do things that work along with their individual industry strategies, as well as what we at NASA think are the big barriers to start addressing to make this a reality for the country." 🌐

Transcend Refines Design for Intercity VTOL

- > THERE HAS BEEN A SWITCH TO A BIGGER ENGINE AS DESIGN MATURES
- > LARGER TAIL FAN IMPROVES STABILITY AND CONTROL

Guy Norris Los Angeles

Targeting intercity flights with a new generation of vertical-takeoff-and-landing (VTOL) aircraft, startup Transcend Air is poised to start subscale flight tests of a revised version of its tiltwing Vy 400.

svelte nacelles. The fact is, in terms of wetted area, the aircraft is largely unchanged.”

The vehicle will be stretched slightly to increase the effectiveness of an electric-driven tail fan used for stability and control. “We’re trying to front-load the design as much as possible, which is why we’ve been flying it at one-fifth scale. We have learned a few things, one of which is that it would be nice if it is a little bit longer. We are going to be extending the tail fan further backward and making the fan larger for additional pitch authority,” says Bruell.

The more powerful tail fan, powered by an engine-driven Yasa electric motor, is being installed on one of the company’s two 7.5-ft.-span test vehicles, says Chief Operating Officer Peter Schmidt, former president and CEO of air-taxi operator Linear Air. “We are embarking on helicopter-mode qualification flights prior to getting back on our truck-based test rig for airplane-mode data collection,” he adds.

Schmidt also says analysis and simulation of Transcend Air’s latest full-scale propeller design “achieves our high/hot hover-out-of-ground-effect and max cruise performance targets while reducing noise, rotating at just over Mach 0.5 at the tips in hover.”

With Transcend targeting inner-city sites such as floating helipads on rivers for operating locations, the company says high performance with low noise is critical to its business

model. The Vy 400’s three-blade rotors will be designed for a maximum climb rate of 4,750 fpm and hover speed of 40 mph.

Work is also underway to perfect the fly-by-wire flight control system, which will use electric actuators and incorporate envelope protection to ensure a safe transition between vertical and forward flight.

“We have collective [pitch], wing tilt, a throttle, and we have pitch, roll and yaw,” says Schmidt. “This lets us control the degrees of freedom right now, so we are adding control laws over time. We go out and fly it and see how it responds. In helicopter mode the aircraft self-levels, and I can transition by adding collective to get whatever rate of climb I want and by tilting the wing down. The result is it’s really two buttons right now to go from take-off to transition and it would be trivial to totally automate that.”

Tests of the prototype version of the flight control software and refinement of the control laws are being undertaken for the full-scale Vy 400 using the X-Plane flight simulator. “We have achieved full-envelope stability augmentation in all flight modes, including ‘push-button’ takeoffs and transitions, and are now fine-tuning handling qualities,” Schmidt says.

Intended to be certified under the



The Vy 400 is a single-turbine, five-passenger tiltwing VTOL being designed for scheduled intercity services.

The Boston-based company is designing the Vy 400 for scheduled mass-transit services with a pilot and up to five passengers on busy routes such as New York-Boston and Los Angeles-San Francisco. With a maximum takeoff gross weight of almost 7,000 lb. and a useful load of 2,190 lb., the pressurized aircraft is targeted at cruise speeds up to 405 mph (350 kt.) and operating altitudes up to 20,000 ft.

The Vy 400 is designed around a single turboshaft engine that is mounted in the rear fuselage and drives wingtip propellers via gearboxes and shafts. The company originally planned to use a 1,700-shp Pratt & Whitney PT6A-67F, similar to the -67A variant powering Leonardo’s AW609 civil tiltrotor, but says it will now use a 2,000-shp-class CT7-2E1, a version of General Electric’s CT7/T700 family powering the AW149/189 helicopters.

“We have come to realize that, with the sizing of the geartrain at this point, we are going to end up with a CT7,” says Transcend CEO Gregory Bruell. “Engine selection is driven entirely by weight and size. We could put smaller gearboxes in there if we had higher-speed driveshafts in the wing, but we wanted to stick with our



A larger electric-driven tail fan will improve stability and control in vertical flight mode.

combined FAA Part 23 commuter, Part 27 rotorcraft and Part 21.17(b) tiltwing/tiltrotor categories, the Vy 400 is targeted at entry into service around the middle of the decade. Depending on the completion of additional funding rounds, the program could come together in under three years, says Schmidt. “It’s a little ambitious, but it is a very simple aircraft,” he adds. ☺



Europe Provides First Guidance to Industry on Applying AI to Aviation

- > EASA EXPECTS FIRST MACHINE-LEARNING APPROVALS BY 2025
- > EUROCONTROL WANTS TO ACCELERATE USE OF AI IN ATM

Thierry Dubois Lyon, France

Europe is taking a lead in providing guidance on how artificial intelligence could affect aviation. Describing it as potentially the most disruptive innovation facing the industry, the European Union Aviation Safety Agency (EASA) has released a road map for AI, while Eurocontrol has published an action plan to accelerate development of AI in aviation and air traffic management.

“The possibilities of AI will increasingly be used in aviation and will make autonomous flights, preventive maintenance and optimization of air traffic management possible,” said EASA Executive Director Patrick Ky in February at the unveiling of the first edition of the agency’s Artificial Intelligence Roadmap.

The document, which will be updated annually, begins to address manufacturers’ questions on how to certify AI-based systems. Central to EASA’s vision is the concept of trustworthiness. According to the road map, the building blocks of trustworthy AI are learning assurance, explainability and safety risk mitigation. The concept of learning assurance includes data preparation, algorithm selection and parameter tuning.

Explainable AI needs further investigation, the document says, as machine-learning (ML) behaviors cannot be validated using conventional approaches because they lack predictability and explainability. “Consequently, there is a need to make more understandable the conditions that led to a given output,” the road map states.

ML is expected to change the relationship between the pilot and the aircraft. “AI may assist the crew by advising on routine tasks or . . . may help the crew make decisions in high-workload circumstances,” the road map states. EASA identifies icing detection as another potential application.

After talking to “major players,” including Airbus, EASA

Large data flows make air traffic management well suited to artificial intelligence, Eurocontrol says.

concludes that industry anticipates the first approval of an ML system in commercial aviation in 2025. Single-pilot operations would debut in 2030, and autonomous operations would follow in 2035.

To meet these expectations, EASA plans to publish the “first usable guidance” in 2021 for ML-based applications in “human assistance and augmentation.” Guidance for “human-machine collaboration” would follow in 2022 and that for “more autonomous” aircraft in 2024. EASA says it received the first applications in 2019 for projects planning to make “limited use of AI/ML solutions.”

Eurocontrol, meanwhile, believes aviation and air traffic management (ATM) are ideally placed to take full advantage of AI. An action plan to advance the technology’s use is detailed in the Fly AI report released on March 5 and prepared with partners including Airbus, Thales and the International Air Transport Association.

The goal of the report is “to advance understanding among aviation and ATM actors of AI and its potential, to ‘demystify AI’ and to help accelerate its uptake in aviation,” Eurocontrol says, adding that aviation and ATM can take advantage of AI because of the large data flows the sector generates.

AI has huge potential for use in areas where it can “reduce human workload or increase human capabilities in complex scenarios,” the report states. Air traffic controllers, pilots, airport operators and cybersecurity officers could therefore benefit, it adds. AI can also play a fundamental role as new users such as drone operators seek to enter the airspace.

Functions for AI will include tools for capacity prediction, conflict detection, traffic advisories and resolutions. The technology is expected to “[enhance the] use of scarce resources” such as airspace, runways and staff, the report says.

The report’s action plan recommends the creation of a federated AI infrastructure for training and AI application development, accelerated deployment of AI in cyber and non-safety-critical areas, more research into safety-critical operations, and fostering of an “AI culture” through training and skill-building and through partnerships with other industrial sectors.

“With European aviation facing growing pressure to reduce its environmental impact, as well as persistent capacity bottlenecks, we need more sophisticated changes on the ground and in the air—and quickly,” European Transport Commissioner Adina Vaelean said at the report’s unveiling. “AI can be a key ally in pursuit of this goal.”

Servicing in Space

> DARPA TO SUPPLY ROBOTIC PAYLOAD FOR MRV SERVICER

> MRV WILL BUILD ON NORTHROP'S LIFE-EXTENSION MEV

Graham Warwick and Jen DiMascio Washington

Hard on the heels of its first Mission Extension Vehicle (MEV) docking with a client satellite in geostationary orbit, Northrop Grumman subsidiary SpaceLogistics has signed on as DARPA's commercial partner for the Robotic Servicing of Geosynchronous Satellites (RSGS) program.

The role became available in January 2019, when Maxar Technologies' subsidiary SSL withdrew as DARPA's commercial partner, citing financial pressures.

Under the agreement, DARPA will provide the robotics payload for SpaceLogistics' Mission Robotic Vehicle (MRV), already planned as its next step in satellite servicing after

Northrop's first MEV docked with Intelsat's IS-901 satellite just outside GEO on Feb. 25. Once attached, MEV-1 took over position and attitude control of the satellite and is now moving it back to GEO, where it will resume service.

A second servicer, MEV-2, is to be launched this year to dock with a second Intelsat satellite in GEO. On completion of their initial five-year missions, MEV-1 and -2 will undock and are expected to provide life-extension services to other satellites for

DARPA will provide the robotics payload for Northrop Grumman's MRV satellite-servicing vehicle.



NORTHROP GRUMMAN

the MEV. The company will provide the spacecraft bus and will launch and operate the MRV during its on-orbit demonstration for DARPA, then continue to own and operate the robotic servicer in geostationary orbit (GEO)—providing services to commercial and government customers.

The MRV bus will leverage the MEV, which is designed to attach itself to a client satellite and extend its operational life in GEO by up to five years. The MEV, in turn, is based on Northrop Grumman's GEOSTAR commercial satellite bus.

another 10 years, SpaceLogistics says.

Meanwhile, Northrop has begun development of the Mission Extension Pod (MEP), a smaller and less expensive propulsion module that the MRV will attach to a client spacecraft. The MEP performs orbital control only for up to five years but remains attached permanently to the satellite.

The DARPA-supplied payload for the MRV, developed and integrated by the U.S. Naval Research Laboratory, comprises two dexterous robotic manipulator arms along with multiple sensors and several interchangeable tools.

RSGS plans to demonstrate rendezvous, inspection, repair, reconfiguration, refueling and relocation of a cooperating GEO satellite. "The new robotics technology on this mission advances our vision to build a fleet of satellite-servicing vehicles that provide customers with a variety of options to select the type of life-extension or in-orbit repairs they need," says Tom Wilson, president of SpaceLogistics.

Northrop and Intelsat hailed the autonomous docking of MEV-1 with IS-901 as "historic." After launch by Proton rocket in October from Baikonur, Kazakhstan, the servicing spacecraft used its electric propulsion to raise its orbit, while IS-901 was moved to a graveyard orbit 300 km above GEO.

On Feb. 1, the MEV-1 arrived in the same orbit as IS-901 and began maneuvering to rendezvous and dock with the satellite. The servicing spacecraft began a series of approach maneuvers during which Northrop tested and tuned the visual, infrared and lidar sensors used for rendezvous and docking.

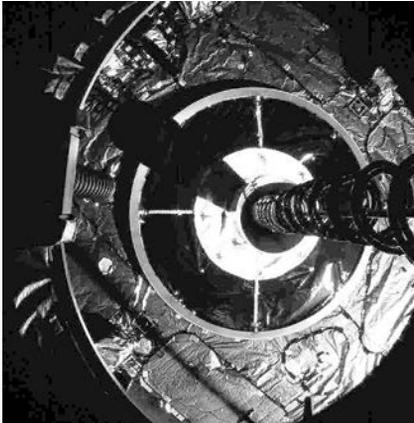
By Feb. 24, the distance between MEV-1 and IS-901 had been reduced to 80 m (260 ft.), and in the early hours of Feb. 25, the spacecraft approached its final waypoint. There, it awaited permission from ground control to proceed, says Joe Anderson, vice president of operations and business development for SpaceLogistics.

Mission control gave the command to dock and MEV-1 autonomously inserted its docking probe into the nozzle and through the throat of IS-901's liquid apogee engine. The probe deployed a capture mechanism and then retracted, pulling stanchions on the servicer up against the satellite's launch adapter ring and securing the spacecraft together.

The servicing spacecraft then took control of IS-901's position and attitude, reorienting the satellite back toward Earth within a few seconds, Anderson says. The MEV-1's propulsion system is now moving the combined spacecraft back to geosynchronous orbit, where it is expected to resume customer service by late April or early May, says Intelsat CEO Stephen Spengler.

Northrop declines to reveal the cost of MEV-1, but IS-901 had only months of fuel remaining and Intelsat "saw a solid business case to use the service

to extend the customer service life of IS-901 for another five years,” Spengler says. “The economics made sense for us in terms of revenues generated and capital investment deferred.”



NORTHROP GRUMMAN

Services were shut down, and IS-901 was moved to graveyard orbit as a safety precaution before the rendezvous with MEV-1, but the transient effects observed during docking of the two spacecraft were “much less than

simulated,” says Jean-Luc Froeliger, vice president of space systems engineering and operations at Intelsat.

Due to the low transients, during the next mission the satellite will not be moved to graveyard orbit for its docking with MEV-2. It will instead remain in its operational GEO location providing uninterrupted service to customers, he says.

The docking probe on Northrop’s MEV-1 captured Intelsat 901 via its liquid apogee engine nozzle.

The feat has excited at least one potential customer: the U.S. Defense Department. “To take a satellite that was at end-of-life and have another satellite take control of it and give it new life—that has opened up a lot of thinking for us,” says John London, chief engineer for space and strategic systems at U.S. Army Space and Missile Defense Command.

“We are now looking at ways that we can repurpose not just communication satellites but other satellites

that are at end-of-life—or given up for dead—and finding ways to reuse them, maybe in different ways,” he says.

Satellite manufacturer Airbus is less certain of the value. “We had our own activity, which we called the SpaceTug. We stopped it at the preliminary design review at the end of 2018. The technology was feasible, but we had significant questions about the business case,” Oliver Juckenhoefel, Airbus senior vice president of on-orbit services and exploration, told reporters at the Satellite 2020 show.

“In 2017, when we started these initiatives, there was so much confusion in the market. Companies were interested in temporarily prolonging the life of satellites to avoid having to make an investment decision,” he says.

“We don’t know whether there will be a market or not. Northrop seems to be convinced, and I like that very much. We are not investing our own money because we don’t see a commercial market, but we believe we need to be prepared,” Juckenhoefel says. ☺

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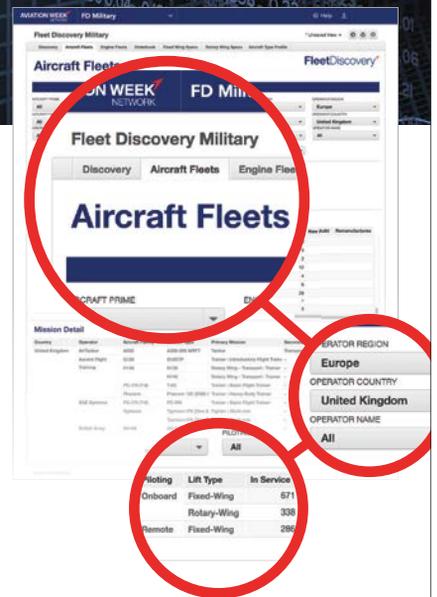
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BUILDING ARTEMIS

> NASA SPEEDING UP
PROCUREMENT PROCESSES

> ALTERNATIVE CONTRACTING
METHODS TAPPED FOR MOON PLAN

> LUNAR POWER AND PROPULSION
ELEMENT CONTRACT SIGNED IN HOURS

Irene Klotz Washington

Whether or not NASA makes its 2024 deadline for landing astronauts on the Moon remains to be seen, but the expedited schedule, ordered by President Donald Trump, already has made an impact in the key but understated realm of government contracting.

NASA originally targeted 2028 for its first crewed Moon landing since the Apollo 17 mission in 1972. Prior to landing astronauts, the agency plans to assemble a small outpost in lunar orbit, beginning with a commercially procured power and propulsion element (PPE).

The PPE competition was underway when the Trump administration in March 2019 ordered NASA to shave four years off the schedule to land astronauts on the Moon, under a program now known as Artemis.

Two months later, on May 23, NASA selected Maxar Technologies to provide the PPE—and signed the contract the same day. “It was only a few hours between notification and receipt of the fully executed contract,” says Al Tadros, Maxar vice president of Space Infrastructure and Civil Space.

Typically, U.S. government contracts with the complexity and value of the \$375 million PPE agreement take a few months to negotiate and finalize, he adds.

Having the 2024 deadline has been extremely important from a procurement perspective, notes Michael

Gold, an attorney and business development guru who chaired the NASA Advisory Council Regulatory and Policy Committee until joining the agency in December.

“Without a date, without that goal, procurements can lag. There’s less pressure, priority and emphasis to move forward,” says Gold, who serves as the acting associate administrator for international and interagency relations.

NASA has always been ahead of the curve when it comes to government procurement methods.

“The Space Act Agreement (SAA) vehicle—the original Other Transaction Authority—was developed explicitly and originally for NASA because we simply didn’t know what we’d be dealing with in space,” Gold tells Aviation Week. “And therefore the government deemed it necessary for the agency to have an inherently flexible procurement vehicle.”

Facing the end of the space shuttle program, NASA turned to SAAs to woo companies first to invest in developing cargo transports to the International Space Station and later to work on space taxis to ferry astronauts.

Maxar is building the Lunar Gateway power and propulsion element under an unusual partnership arrangement with NASA.

Once commercial capabilities were demonstrated, the agency purchased flight services from SpaceX and Northrop Grumman for station resupply runs, with a third vendor, Sierra Nevada, slated to begin flying cargo in 2021. SpaceX and Boeing are following a similar path toward crewed flights.

For the deep-space Artemis initiative, NASA is taking its alternative contracting methodologies into uncharted terrain. The PPE, for example, will be developed, launched, owned and operated by Maxar for a one-year demonstration period, then either leased or purchased by NASA to become part of the lunar-orbiting Gateway.

In late March or April, NASA expects to award Artemis cargo flight service contracts. Also pending are study contracts for commercially provided human lunar landing systems.

The elements of the Artemis program, primarily based on technical proposals and business plans offered in response to Broad Agency Announcements (BAA), will be integrated by NASA following evaluations and selections of industry partners.

Under the umbrella of NASA’s Next-STEP (Space Technologies for Exploration Partnerships) program, the agency has issued BAAs for two dozen

types of services, spacecraft or studies, including: the PPE; Human Landing System; trash compacting; Earth-orbiting, free-flying platforms; deep-space habitats; in-situ resource utilization; and space communication and navigation networks, among others.

“The BAA is extraordinarily important because it allows private sector entities to suggest creative ways to meet government objectives and goals and [it] avoids making the government entirely prescriptive in terms of what it may need or want,” Gold says.

“When the government asks for specific goals or objectives—rather than saying how it needs to get there—you can often obtain some very creative, low-cost ideas that actually enhance safety, which perhaps those in government wouldn’t have thought of.

“Additionally, there is inherent flexibility to the BAA process that allows the government to synthesize feedback it gets from companies and adopt what will be the best approach,” Gold says. “That may be something that the government wasn’t initially thinking or that the private sector wasn’t initially

thinking. It can synthesize both.”

Prescriptive solicitations have their place, but Gold notes, “It’s interesting and healthy for NASA to be looking at the different arrows it has in its quiver for procurement and using the right tool for the job.”

The key is to match the right oversight, incentives, contract structure, payment plan and testing plan, says Douglas Loverro, NASA associate administrator for Human Exploration and Operations.

“You have to look at all of the elements that make up the acquisition strategy . . . and marry those together to create a tight web that ensures success,” Loverro says. “I’ve been doing government contracting for 40 years, and I have used every form of contract. No kind of contract is immune from errors.”

NASA took a traditional contracting approach to develop the Space Launch System (SLS) rocket, Orion capsule and related ground support systems, a project that could consume \$50 billion by 2024, the NASA Office of the Inspector General wrote in a

report released March 10.

SLS and Orion are being developed under cost-plus-award-fee agreements held by prime contractors Boeing and Lockheed Martin, respectively.

Despite cost overruns and program delays, the agency is steadfast in its support of the SLS and Orion, arguing that it is the only system with the lift capacity and maturity to meet the 2024 deadline for landing astronauts on the Moon.

NASA also is unflagging in its long-term commitment to SLS and Orion, though the agency is watching a high-profile, privately funded effort by SpaceX to develop a Mars-class reusable transportation system called Starship. Blue Origin also has plans for a super-heavy reusable lifter called New Armstrong.

SLS and Orion are expected to debut in mid-to-late 2021 with an uncrewed flight test around the Moon. That mission would set the stage for a crewed lunar flyby in 2022-23 and a crewed landing on the surface of the Moon during the third SLS-Orion flight, possibly in 2024. 🌕

SLS Busts Its Budget—Again

Irene Klotz Washington

THE COST OF NASA’S SPACE LAUNCH SYSTEM (SLS)

rocket continues to soar, with new estimates reaching more than \$18 billion before the booster’s debut in 2021 and a price tag of nearly \$23 billion if a crewed flight test slips to 2023.

So concludes NASA Inspector General Paul Martin, whose office flagged the SLS program on March 10 for exceeding its Agency Baseline Commitment (ABC)—the cost and schedule commitment to Congress against which a program is measured—by at least 33% on Sept. 30, the end of fiscal 2019.

The SLS is likely to surpass its congressionally approved budget by 43% if the rocket’s first flight is postponed beyond November, which is all but official. NASA is expected to announce a new target launch date of mid-to-late 2021 for Artemis-1, an uncrewed trial run of the SLS-launched Orion capsule around the Moon.

Combined with the Orion capsule and ground support systems, NASA could spend \$50 billion on the Artemis lunar exploration initiative by the time astronauts land on the Moon in 2024, as mandated by President Donald Trump, the Office of Inspector General (OIG) audit shows.

Part of the SLS overrun is due to NASA removing from the program work it said was not tied to the first launch of the SLS, though it kept \$889 million allotted for that work in

the project’s budget. The accounting maneuver temporarily masked the fact that the SLS was more than 30% over budget, the level that mandates congressional notification and a program rebaselining, the OIG audit shows.

Another \$2 billion in cost overruns are due to technical problems Boeing encountered building the SLS core stage, issues with the propellant liner used in the Northrop Grumman-built solid rocket boosters and development of new RS-25 engine controllers by Aerojet Rocketdyne, the audit shows.

As of December 2019, NASA had obligated \$14.8 billion to the SLS program and was expected to spend a total of \$17.4 billion if the Artemis-1 launch occurs in November, the OIG said. The figures include preparations for the next two Artemis missions, new engine development and improved boosters.

However, in January, NASA revised the timeline and now expects the Artemis-1 launch to slip to spring 2021, which would cause SLS program costs to rise to \$18.3 billion, the report says. If Artemis-2, a crewed flight around the Moon, slips to 2023, program costs would climb to approximately \$22.8 billion.

NASA initially planned to launch the first SLS mission by the end of 2019, but the program was delayed primarily by “management, technical and infrastructure issues driven mostly by Boeing’s poor performance,” the OIG said in an October 2018 audit.

The new audit says contractor performance has improved but NASA is still struggling to manage SLS program costs and schedule. 🌕

TO THE FINISH

- > FALCON ROCKETS ARE SOLE HERITAGE OFFERING
- > ULA BUSINESS BASED ON WINNING ITS BID

Irene Klotz Promontory, Utah, and Washington

United Launch Alliance (ULA) CEO Tory Bruno is keen on competition, even if that means losing a government contract every now and then, as happened in February when NASA chose a SpaceX Falcon Heavy to launch a science probe to the metal asteroid Psyche in 2022 for \$117 million.

ULA had offered Psyche mission launch services aboard its workhorse Atlas V for an undisclosed price. “Can’t win them all,” Bruno tells Aviation Week. “We win about half, but that’s OK. That’s how competition is supposed to work.

“It’s healthy for the government. It’s healthy for the industry . . . because we try to be as efficient as we can and to differentiate ourselves, which ultimately usually results in more value for the customer, either in capabilities or in prices,” he adds.

Bruno’s mettle is being put to the test. This summer, a heated two-year competition to provide national se-

curity space launch (NSSL) services through 2027 concludes with the U.S. Air Force deciding whether to retain incumbents ULA and SpaceX or replace one or both with Northrop Grumman and/or Blue Origin.

The Air Force Space and Missile Systems Center, in partnership with the National Reconnaissance Office, plans to award firm fixed-price, indefinite-delivery contracts to two domestic launch service providers for procurements in fiscal 2020-24, with work split 60/40%.

The NSSL Phase 2 Launch Service Procurement (LSP)—the first such solicitation since 2005—is designed

A SpaceX Falcon Heavy lifted off on June 25, 2019, on the STP-2 mission for the U.S. Air Force.

to end dependence on Russian rocket engines for national security space launches, reduce launch costs and spur competition for current and future national security space launches.

Unlike its competitors, ULA’s business plan rests on winning a Phase 2 award. “We have an entire business plan that presumes we are going to win Phase 2,” Bruno said during a March 10 media roundtable at the Satellite 2020 conference in Washington.

If ULA does not win, he added, “We’d have to go evaluate that.”

Based on satellite orders compiled by several industry association surveys, Bruno figures there is enough business for two domestic medium-to-heavy-lift launch service providers, and he is confident ULA will be one of them.

“There isn’t much rocket science to this,” Bruno said. “The launch service provider is at the end of a 5-7-year-long chain. It’s going to be about 30-35 launches a year for the next several years,” he said during a March 11 panel session at the conference. “We

all need about 8-12 launches a year, at least, to be a sustainable, viable business. That makes room for four [launch service providers].

“The Russians will always have one—it is state-sponsored—they will make sure. Ariane will always exist, the Europeans will make sure. That leaves two for the U.S. because we want to ensure space access via two providers. So that is the right number, and that’s why the Air Force will select two very shortly this summer,” Bruno says.

THE SPACEX VIEW

SpaceX looks at the launch market pie with a different eye. First, the company expects more than half of its projected 35-38 Falcon launches this year to carry Starlink satellites manufactured, owned and operated by SpaceX into low Earth orbit (LEO), a project intended to provide global high-speed, low-latency internet service.

SpaceX’s sixth batch of 60 Starlinks reached orbit on March 18, bringing the constellation head count to about 360. When that number doubles, SpaceX expects to be able to provide seamless internet coverage covering latitudes about 25 deg. north and south of the equator.

After 24 launches, with approximately 1,440 Starlinks in orbit, the network will be capable of full global coverage, according to SpaceX President and Chief Operating Officer Gwynne Shotwell.

Ultimately, SpaceX plans to operate approximately 12,000 satellites, with a possible expansion to 42,000. The company is still working with the International Telecommunication Union for spectrum allocation and with individual countries for permission to transmit data to and from non-U.S. territories.

Starlink’s raison d’être is to bring in enough revenue to carry out the space colonization dream of tech entrepreneur Elon Musk, who founded SpaceX in 2002 with the goal of creating technologies for interplanetary transportation, with a particular eye on Mars.

Toward that end Musk, who also serves as SpaceX CEO and chief engineer, is focused on developing the Starship, a two-stage, fully reusable transportation system capable of placing 110 tons (100 metric tons) into LEO. By comparison, the 1960s-era single-use Saturn V Moon rocket could put 154 tons into LEO.

SpaceX is counting on revenue from the Starlink constellation to fast-track Starship development. Flying cargo and crew to the International Space Station and launching commercial and government satellites on the existing Falcon 9 and Falcon Heavy fleet can bring in up to \$3 billion a year, Musk said during a March 9 keynote address at Satellite 2020.

Providing broadband should generate an order of magnitude more revenue, probably about \$30 billion a year—a fraction of the current \$2.8

trillion value of the telecommunications industry, Musk says. “Starlink is not some huge threat to telcos. In fact, it will be helpful to telcos because Starlink will serve the hardest-to-serve customers that telcos otherwise have problems with,” using landlines or cell-phone towers, he adds.

Shotwell says that even without Starlink, SpaceX is profitable. “Starlink is additive to our business,” she told reporters during a media roundtable in October. “We make money on the core business of SpaceX, which is Falcon 9, Falcon Heavy and Dragons.

“We could do Starship just on our own operating income, on our revenue, if we were to spread it out over time,” she added. “But Elon wants to get things done quickly, and so we’re spending a lot of money on advancing Starship and Starlink. SpaceX does not need Starlink to be a healthy business.”

In support of Phase 2, SpaceX has unveiled plans for a movable tower at its Falcon launch base at NASA’s Kennedy Space Center in Florida. The 284-ft.-tall gantry features 11 floors and doors to shield Falcon 9 and Falcon

A structural test article of ULA’s Vulcan rocket underwent fit checks at Cape Canaveral AFS Space Launch Complex 41.



Heavy rockets from rain and wind, while providing a controlled environment to hoist payloads on top of the vehicles as they stand vertically at the pad.

SpaceX currently installs payloads horizontally inside hangars near its three launchpads. Some of the national security missions, however, require vertical integration. SpaceX also is working to qualify a longer payload shroud, which likewise is required for some NSSL missions.

STARRY-EYED

SpaceX’s passion for the Starship, previously known as the Big Falcon Rocket, caused a rare misstep in the company’s quest for U.S. government launch contracts when it included a small role for the megabooster in its LSP developmental Launch Service Agreements (LSA) proposal, a precursor to the ongoing competition for launch services.

In 2018, the Air Force awarded three LSA con-

tracts, collectively worth about \$2 billion, to ULA, Northrop Grumman and Blue Origin to help defray the costs of developing launch-system prototypes aimed at fulfilling various national security payload delivery requirements.

SpaceX's LSA bid included use of the Starship for launch of some of the heaviest payloads and most challenging missions in 2025 and beyond, a scenario the Air Force deemed "high-risk." SpaceX responded in May 2019 with a federal lawsuit, challenging the Air Force's procurement process.

The lawsuit is under consideration in U.S. District Court for the Central District of California. An LSA award was not necessary for companies to compete for the LSP Phase 2 program.

Ironically, iconoclastic SpaceX, which previously sued the Air Force to speed up the breakup of ULA's 2006-16 monopoly on national security space launch services, is the only Phase 2 contender offering an existing and certified family of launchers. The company, which publishes base pricing on its website, has not disclosed what it would charge for NSSL missions, but SpaceX is well-known for undercutting its competition.

Ten years ago, Iridium shopped for launch services to put its next-generation network of 75 communications satellites into orbit. It signed with SpaceX, which at the time was preparing for the first flight of the Falcon 9.

SpaceX's bid for the Iridium Next launch campaign—which consisted of eight flights from January 2017 to January 2019 from Vandenberg AFB in California—was \$500 million. "My next price from there was \$1.2 billion to launch the same 75 satellites," says Iridium CEO Matt Desch. "Thank God for SpaceX . . . I'm not sure I could have afforded the second-best price."

Six years later, SpaceX broke ULA's monopoly on the Air Force's launch business with an \$83 million winning bid to fly a GPS 3 satellite, undercutting the government's cost estimate, based on previous GPS launches by ULA, by about 40%, the Space and Missile Systems Center said at the time.

Price and performance may tip the scales in SpaceX's favor for the upcoming Phase 2 LSP awards. With its March 18 launch, SpaceX has carried out 83 Falcon 9 missions, with one in-flight failure and one accident during a prelaunch static test fire that cost another booster and payload. The

Falcon Heavy has flown three times, all successfully.

THE ROCKET THAT SCRUM BUILT

One company hoping to wrest the NSSL business away from the incumbents is Northrop Grumman, which presents a very different view of launch market viability. "The Air Force's intent from the beginning is to make sure that our business case didn't depend on them with large numbers of launches," says Northrop's Charlie Precourt, vice president of propulsion systems.

"We're not a launch vehicle searching for lots of different payloads," he adds. "We're a launch vehicle that is built on existing manufacturing lines, facilities and workforce infrastructure."

Northrop's Phase 2 offering, the Omega, can close its business case with just 3-4 launches per year, far below ULA's estimate of what it takes to sustain a viable medium- to heavy-lift launch service program.

Northrop is heavily leveraging investments and existing work for NASA and the defense community to develop the Omega, a family of two-stage, solid-propellant boosters topped with an Aerojet Rocketdyne RL10 upper stage. ULA also is using an RL10 for the upper stage of the Vulcan.

"The core of the Omega rocket is in form, fit and function the same as a segment of the SLS [Space Launch System] booster," says Precourt. "What we're doing is a little bit differ-

ent than what a launch vehicle company would normally do, which is to pursue lots of different payload customers. We meet that business need for the Air Force in a different way."

But the Omega also is a departure from Northrop's current programs, which include the five-segment solid-rocket motors for NASA's SLS, the air-launched Pegasus booster, the Minotaur and Antares. Northrop used an agile development system called scrum—initially developed by teams to write software in sprints—to design and manufacture the Omega.

"We like to call Omega the rocket that scrum built," says Precourt. "Scrum is about moving faster, how to innovate to go faster and do more in less time."

Between the May 2019 and February 2020 static test firings of the Omega's first and second stages in Promontory, Utah, engineers used scrum methodologies to apply lessons learned, such as determining what the environments were like inside the motor and how it behaves when fired, Precourt says.

Both static firings were successful, completing full-scale engine testings planned prior to the Omega's debut launch in 2021.

However, the May test, during which the Omega's two 31-ft. solid-propellant rocket motors were ignited, ended with the booster's 18-ft.-long nozzle breaking apart, a function of atmospheric conditions during test-

Northrop Grumman test-fired the second stage of its Omega rocket on Feb. 27 in Utah.



ing and not an issue for certification or flight, Northrop says.

“The nozzle was just one part of the design we analyzed. Our engineers ran in sprints, with the customer as part of the team, to assess data, anchor models and optimize the design,” says Precourt. “By taking a little extra time between the two tests and utilizing scrum, we were able to fully test design improvements without any impact to our launch-readiness date. We’re deploying scrum more broadly across the plant as we go.”

Under terms of Northrop’s \$792 million LSA agreement, awarded in 2018 for Omega development and certification work, the company plans to conduct two more full-duration static tests of the first and second stages after the Omega’s first two flights, which will be used to certify the booster for national space security missions.

Northrop is developing the Omega primarily to provide launch services to the Air Force, but it is also offering the rocket commercially. In December, the company announced it had a customer for the Omega’s first flight, one of two missions required prior to flying high-value national security payloads.

The debut mission will carry one or two Saturn NationSat geostationary communications satellites. Northrop said it is “converging on an agreement” with a customer for the Omega’s second flight, which is expected to launch next summer, says spokeswoman Jennifer Bowman.



Blue Origin's first payload fairing for the New Glenn rocket was manufactured in Florida.

Winning a follow-on Phase 2 contract is a high priority for Northrop. “We’ve been working really hard on that,” Precourt tells Aviation Week “Northrop as an entire company is focused on national security space.

“We do threat assessment, mission planning, mission control and operations, satellite design and manufacturing [and] direct support of information to the warfighter,” he says. “Launch is a piece of that full-value stream of delivering to the warfighter, so NSSL fits right into the DNA of the company. We’re really determined to deliver for the Air Force.”

As to what it will take to dethrone an incumbent, Precourt says it is not that unusual: “It all comes down to who is best-prepared and best meets the need. That’s what we’re working hard to do.”

GETTING A TOE HOLD

Among the four contenders for the Air Force’s launch business, Blue Origin’s New Glenn offering may be the longest-shot, but even if it does not win a Phase 2 contract, it fully expects to be a key part of the team. That is because the company’s BE-4 engines will power the first stages of both ULAs Vulcan rocket and Blue’s New Glenn.

Company founder Jeff Bezos has invested \$2.5 billion in the New Glenn, including a new \$200 million, 350,000-ft.² factory and office complex in Huntsville, Alabama, where BE-4 engines and the New Glenn’s BE-3U upper stages will be manufactured.

Blue Origin also is expanding New Glenn manufacturing facilities adjacent to Kennedy Space Center. In March,

the normally low-profile company displayed videos of the New Glenn’s newly completed mission control center, a first-stage fuel tank, which is the rocket’s largest structure, and the first completed 23-ft.-long payload fairing.

At nearby Cape Canaveral AFS, a launch complex for the New Glenn is under construction, with the booster’s debut expected in late 2021.

Like SpaceX and Northrop, Blue Origin’s future does not hinge on winning a Phase 2 contract. The company won LSA funding, which it says it is using to cover NSSL certification costs and program requirements to develop a West Coast launch site for polar orbits.

Blue Origin has signed New Glenn launch contracts with at least five customers—Eutelsat, μ Space Corp. of Thailand, Sky Perfect JSAT, OneWeb and Telesat—several of which are buying multiple flights.

Powered by seven BE-4 engines on its reusable first stage, the New Glenn is designed to carry nearly 50 tons to LEO. “And that is the smallest orbital vehicle we are planning to build and launch,” says Clay Mowry, Blue Origin vice president of sales, marketing and customer experience.

Like SpaceX’s Musk, Bezos aims to parlay his company’s space transportation technology into a future that more closely resembles the science fiction novels both men hold dear. Bezos’ vision is for millions of people to be living and working off Earth.

ULA and Northrop, meanwhile, seek only to serve the national security mission.

The Air Force has never had such ripe pickings. ☪



NORTHROP GRUMMAN

Space Force Ups the Launch Ante

- > 45TH SPACE FORCE MUST IMPROVE SPACE RANGE INFRASTRUCTURE
- > INDUSTRY IS WORKING TO INCORPORATE AN AUTONOMOUS FLIGHT SAFETY STANDARD



A Falcon 9 rocket carrying a payload of Starlink satellites lifted off from Cape Canaveral AFS as the first official U.S. Space Force launch.

AIRMAN 1ST CLASS ZOE THACKER/U.S. AIR FORCE

Lee Hudson Orlando, Florida

The U.S. Space Force is taking steps to achieve the previously unfathomable goal of launch on demand for both commercial and military customers.

The 45th Space Wing is calling the new goal “Set the Pace for Space,” Brig. Gen. Douglas Schiess, 45th Space Wing commander and Eastern Range director, told Aviation Week in February during the Air Warfare Symposium. The 45th Space Wing, headquartered at Patrick AFB in Florida oversees the preparation and launch of U.S. government and commercial satellites from Cape Canaveral. It is one of five Air Force space wings assigned to the Space Force beginning Dec. 20 when President Donald Trump signed the National Defense Authorization Act for Fiscal Year 2020, which created the new sixth branch of the armed forces.

His predecessor set a goal of 48 liftoffs annually by 2020, almost one a week, while leaving a few periods available for range maintenance, Schiess says. This year, Schiess’ team is prepping for the sixth launch of the X-37B from Cape Canaveral AFS. The X-37B is a reusable and unmanned spacecraft that allows scientists and engineers to conduct experiments in a long-duration space environment.

“The X-37B continues to demon-

strate the importance of a reusable spaceplane,” Air Force Secretary Barbara Barrett says. “Each successive mission advances our nation’s space capabilities.” The X-37B Orbital Test Vehicle conducted on-orbit experiments for 780 days during its mission, breaking its own record by remaining in orbit for more than two years.

The team did not quite meet the 48-launch mark, but Schiess is undeterred. Twenty-four launches occurred in 2018, and 2019 saw 19 “major operations,” including the X-37B landing, he says.

“Some might say, ‘Hey, you’re doing less than you did the year before.’ But really, we had a couple of times during the year where we demonstrated that 48 capability,” Schiess notes.

In July and August 2019, for example, the Air Force launched four times in four weeks, and in December 2019 there were two launches in the same week. In January 2020, Schiess’ team was prepared to launch twice in the same day.

“We want to launch when anybody needs us to launch, whether it is a national security payload or a commercial launch,” he says. Schiess envisions achieving launch on demand by implementing different scheduling practices and improving infrastructure.

The double launch in a single day was planned for two SpaceX liftoffs. With the Falcon 9’s autonomous flight safety system, it is easier to reconfigure the range, providing more flexibility. Autonomous flight safety eliminates the need for the command-destroy system that mission flight control officers operate. They make sure the system is encrypted and an outside entity cannot destroy a rocket. Ultimately, however, the double launch did not take place.

A mark of incremental progress in being more flexible for launch customers is repurposing frequency-control vans and using them for telemetry. Previously, the service placed telemetry antennas all over the range but now can get rid of some of the older infrastructure and work with a mobile version. Schiess says his team is about to accept the first van, and more are in the pipeline.

Gen. John Raymond, chief of space operations and head of U.S. Space Command, issued a mandate to equip all new rockets with an autonomous flight safety system by 2025. The shift is part of a larger strategy known as “range of the future,” a program that will require network infrastructure upgrades by 2022.

This means contenders in the National Security Space Launch competition must incorporate the technology into their rockets, Schiess says. The Pentagon plans to choose two companies for the second phase of the Launch Service Procurement in 2020 for missions spanning 2022-26. Four companies are seeking to win the contracts: Blue Origin, Northrop Grumman, SpaceX and United Launch Alliance.

A direct result of the new specification is redeploying staff to other teams because the mission flight control officers operating the command-destroy system will not be needed once all rockets are outfitted with autonomous flight safety systems. Those personnel can then work on other projects.

By 2030, submarine-launched and intercontinental ballistic missiles must have autonomous flight safety systems, according to Raymond’s decree.

Safety engineers at the 45th Space Wing will still have to certify the rockets outfitted with autonomous flight safety systems for launch, Schiess adds, but they can create a template for the same mission type such as cargo resupply to the International Space Station. ☉

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Aerospace Calendar

To submit Aerospace Calendar Listings

email: aero.calendar@aviationweek.com

March 3 Now May 12-14—JEC World Composites Show. Paris-Nord Villepinte. Paris. See jec-world.events

March 16 Postponed/TBD—AeroDef Manufacturing. Fort Worth Convention Center. Fort Worth. See aerodefevent.com

March 17-19 Now June (date TBD)—Global Aerospace Summit. St. Regis Saadiyat Island Resort. Abu Dhabi. See aerospacesummit.com

March 18-19 Postponed/TBD—PBExpo—Aviation Technology Innovation. Miami Beach Convention Center. Miami Beach. See pbexpo.org

March 24-27 Postponed/TBD—Aircraft Electronics Association International. Nashville, Tennessee. See aea.net/convention/2020

March 30-April 2 Postponed/TBD—36th Space Symposium. Broadmoor Hotel. Colorado Springs. See spacesymposium.org

March 30-April 2 Postponed/TBD—International Air Transport Association Aircraft Interiors Expo. Hamburg Exhibition Hall and Congress. See aircraftinteriorsexpo.com

March 31-April 1 Now June 9-11—Passenger Terminal Expo 2020. Paris Expo Porte de Versailles. Paris. See passengerterminal-expo.com/en

March 31-April 2 Postponed/TBD—SOFEX Jordan. King Abdullah II Air Base. Zarqa, Jordan. See sofexjordan.com

March 31-April 5 Postponed/TBD—FIDAE 2020 International Air & Space Fair. Pudahuel. Santiago, Chile. See fidae.cl

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March 8-10 Now June 7-9—Routes Asia 2020. Chiang Mai, Thailand

March 12 Postponed/TBD—Aviation Week Laureates Awards. Washington.

March 23-24 Postponed/TBD—CAPA Middle East & Africa Aviation Summit. Amman, Jordan.

April 1-2 Now Oct. 26-27—CAPA Airline Leader Summit: Making Money 2020. Dublin.

April 27-28 Now August/September (date TBD)—Urban Air Mobility Americas. Dallas.

April 27-29—Routes Europe 2020. Bergen, Norway.

April 28-29 Now August/September (date TBD)—Military Aviation Logistics & Maintenance Symposium. Dallas.

April 28-30 Now Sept. 1-3—MRO Americas. Dallas.

May 1 Now Nov. 12-13—CAPA LCCs in Asia Summit. Sentosa Island, Singapore.

May 7-8—CAPA Americas Aviation & LCCs Summit. San Juan, Puerto Rico.

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This Too Shall Pass

Not long ago, the biggest concern facing commercial aviation was whether Airbus and Boeing could produce enough aircraft to keep up with demand. Industry leaders fretted about how quickly they could ramp up production and whether the supply chain could keep pace. Some airlines were equally bullish, with American Airlines CEO Doug Parker proclaiming: “I don’t think we’re ever going to lose money again” (see page 16).

After a run of unparalleled and seemingly unstoppable prosperity, aviation and aerospace have flown into a perfect storm. The temporary shutdown of Boeing’s 737 MAX production line has waylaid aerospace suppliers. But that pales in comparison to the impact of the coronavirus pandemic, which first crippled a crucial growth engine, China, and is now decimating air transport markets around the world.

Each day brings a new round of fleet groundings, layoffs and order deferrals or cancellations, which in the coming months will rip through the manufacturing industry like a tornado. A new forecast from Europe projects Airbus will be forced to cut planned production nearly in half in 2021 and may not fully recover before 2027. Boeing is calling on the U.S. government to provide at least \$60 billion in aid to aerospace manufacturers, U.S. airlines want another \$58 billion, airports \$10 billion and the maintenance, repair and overhaul industry \$11 billion. It would not be hyperbole to call this the greatest crisis civil aviation has faced since the dawn of the commercial jet age more than six decades ago.

But amid such panic, we need to take a deep breath and remember that this industry has survived many big challenges: oil price spikes; the Sept. 11, 2001, terrorist attacks; the Severe Acute Respiratory Syndrome; and the 2008-09 global financial meltdown. Each time commercial aviation

has recovered and grown stronger, resuming its long-held trend of outpacing global economic growth.

In one way, the disruption to our lives and businesses caused by the travel restrictions imposed to control the spread of COVID-19 illustrates the degree to which the world has come to rely on air transportation, from enabling commerce to connecting families. This is a crisis on an unprecedented scale for aviation, and there are airlines and businesses that certainly will not survive. But the

extent of the disruption gives hope that demand for air transportation will return unabated once the restrictions are lifted.

It is vital for governments, lawmakers and industry leaders to recognize that aviation will need help getting through such destructive upheaval. But in some cases, the optics will invite legitimate criticism. For example, Boeing has returned nearly \$50 billion to its shareholders over the past five years while investing far less. Now it wants taxpayers to cough up tens of billions for a

bailout? U.S. airlines are no better: They have sent 96% of free cash flow to shareholders over the last five years. And what about those airlines in Europe that should have been allowed to die long ago? Will they use this crisis as leverage for yet another government rescue?

Clearly, there are lessons to be learned from the crisis, and a return to business as usual will not suffice. But in the near term, this is not about partisan politics or competitive advantage. It is about helping a vital industry survive this calamity. Commercial aviation is a connective tissue that underpins global commerce, drives prosperity and supports many millions of jobs. Allowing it to wither is not a realistic option. The coming days will be dark, but rest assured the industry will recover and once again prosper. 

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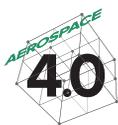
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