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ON THE COVER

Startup small-satellite launch company Virgin Orbit on July 10 completed what it expects to be the final unpowered flight test of its two-stage, liquid-fueled LauncherOne expendable rocket, clearing the way for a trial run to space, possibly by late summer. It is one of many companies that would support the takeoff of a robust smallsat market, Business Editor Michael Bruno’s report begins on page 57, Virgin Orbit photo.

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PARACHUTE IMPERATIVE
The crash of Boeing’s Passenger Air Vehicle (PAV) prototype during a manned test flight in June (June 17-30, p. 10) highlights that ballistic recovery parachutes are a must for future urban air mobility (UAM) aircraft. Admittedly, Boeing’s PAV fell only 20 ft., but it could easily have been hundreds of feet, completely destroying the vehicle.

I expect that future travelers flying UAM vehicles will prefer them to be outfitted with ballistic parachutes as a fail-safe system, as opposed to putting faith in software and glide ratios alone. The recent Boeing 737 MAX accidents that appear to be software-related are examples of why faith in any flight-control software being completely debugged is unsound. Install the parachutes, deal with the weight penalty and assure the flying public their flight will be as safe as possible.

Kevin A. Capps, Corona del Mar, California

THE DC-10’S DURABILITY
The “Up Front” commentary “#Transparency” (May 20-June 2, p. 10) states incorrectly that McDonnell Douglas terminated production of the DC-10 in 1983 because of “a perception that it was operationally unsafe.” The true reason was simply that there were no more orders for it because it (and the similar three-engine L-1011) was no longer fuel-competitive with two-engine widebody designs such as the A300 and Boeing 767.

The mentioned faulty cargo door design (a manual locking mechanism that could be over-torqued by the ground handler) was a simple fix that did not recur once identified. And the “weak” engine mount that caused the crash at Chicago O’Hare was later determined to have been caused by an incorrect maintenance procedure performed by the airline involved.

While no more DC-10s are flying in passenger operations, many still fly as freighters more than 50 years after they were first introduced.

Chris Skillern, San Diego, California

EARTH FIRST
Challenger Center President and CEO Lance Bush recently queried in your magazine (July 15-28, pp. 68-69), “Who is responsible for the future of space exploration?” I salute the enthusiasm of the Challenger Center. I believe that we will go to Mars, although not anytime soon because of serious issues with human health during long-term space travel that have hardly begun to be addressed, as well as the undeniable threats to the Earth’s climate and the environment.

It may be reasonable, affordable and financially rewarding to go to the Moon again. But Mars? I pray I may see humans land there in my time, and at the end of the day humans need to explore; but it might be wise to have the home base sound and healthy before we venture farther than the Earth-Moon system. Our economic resources could easily cover both the issues on Earth and human exploration of Mars if resources from military expenses could be redirected.

Jens Hoeg, Copenhagen, Denmark

CRJ SALES NUMBERS
Your comprehensive article “Bombardier Redefines Its Focus Toward Long-Range Business Jets” (June 17-30, pp. 69-70) states that “almost 2,800 have been sold.” Bombardier’s latest CRJ status report on their website dated March 31, 2019, shows 1,950 orders, 1,899 deliveries, and a backlog of 51. There have possibly been some minor changes since March.

Ken Pickford, Nyon, Switzerland

Editor’s note: The reader is correct.

Address letters to the Editor-in-Chief, Aviation Week & Space Technology, 2212 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.
Chris Emerson has been promoted to president of Airbus Defense and Space, an Airbus Americas subsidiary, from president of Airbus Helicopters Inc.

Romain Trapp has been promoted from Airbus Helicopters Inc.’s chief operating officer to succeed Emerson. With this leadership change, Airbus Helicopters Inc.’s government and military programs, including the UH-72A Lakota, and business functional roles supporting them will move to Airbus Defense and Space. Emerson became president of Airbus Helicopters Inc. in 2015 and before that was chief financial officer of EADS North America. Trapp became Airbus Helicopters Inc.’s chief operating officer in 2016 and was also president of Airbus Helicopters Canada since 2013.

Northrop Grumman CEO and President Kathy J. Warden has been named the company’s board chairman. She succeeds Wes Bush, who is retiring.

Atlas Air Worldwide has promoted John Dietrich to CEO, president and chief operating officer (COO). He succeeds Bill Flynn, who retires next January and will become board chairman. Dietrich was COO/executive vice president of Atlas Air Worldwide Holdings.

John O’Donnell has been named Safran Aerosystems CEO, and Sebastien Weber has been named Safran passenger solutions CEO. They will both have a seat on the executive committee. O’Donnell had been CEO of Zodiac Aerosafety Systems, and Weber was CEO of Zodiac fluid and water and waste division.

NHV Group has appointed Thomas Hutsch chief operating officer and executive committee member. Hutsch had been Allgemeiner Deutscher Automobil Club managing director and before that Airbus Helicopters vice president and service chief engineer for commercial helicopters.

Chris Scolese has been hired as director of the National Reconnaissance Office. Scolese was director of NASA Goddard Space Flight Center in 2012-19 and held other NASA positions, primarily involving Earth sciences missions.

Lockheed Martin has named Frank St. John executive vice president of rotary and mission systems and Scott Greene executive vice president of missiles and fire control, effective Aug. 26. St. John succeeds Dale Bennett, slated to retire at year-end. St. John and Greene also will serve as corporate officers.

The Center for Strategic and Budgetary Assessments has appointed Roger M. Poor chief financial officer. He was a consultant on international development, aerospace engineering and national security IT and worked at a “Big Four” public accounting firm.

Nicolas Ferri has been hired as Grupo Aeromexico’s chief commercial officer and executive vice president. He was Delta Air Lines vice president for Latin and Alliances Americas.

Aerospace private equity firm Acorn Growth has named Laura Siegal partner and executive vice president of finance. Siegal was chief financial officer for NEO Tech, an electronics supplier to aerospace and defense OEMs.

Joshua Hebert, Magellan Jets founder and CEO, will succeed Michael Graham as chairman of the Air Charter Safety Foundation. Graham, director of flight operations safety, security and standardization at Textron Aviation, has been selected by the White House to join the National Transportation Safety Board.

ExpressJet Airlines, a United Express carrier, has hired Gerhard Dupont as managing director of crew resources. He was workforce managing director of operations logistics for Horizon Air.

The U.S. defense and security arm of Thales recently appointed three new members to its board of directors: U.S. Marine Corps Gen. (ret.) James L. Jones, president of Jones Group International and a former National Security Advisor in the Obama administration; Ray O. Johnson, executive in residence with Bessemer Venture Partners and a former Lockheed Martin chief technology officer; and Alan Kessler, a corporate advisor who had been CEO of Thales’ cyber-security business.

Space and Satellite Professionals International has elected BridgeSat CEO Barry Matsu-mori as one of six new directors. The company owns and operates a global network of optical ground stations linked to satellite terminals.

Huaxiang (Edward) Xu has been named chief strategy officer of EHang. He was an equity research analyst at Morgan Stanley, where he covered China’s transportation industries.

HONORS & ELECTIONS
The National Aeronautic Association has established the Bruce Whitman Trophy in honor of Bruce Whitman, the aerospace executive and philanthropist who passed away in October 2018. Whitman has been named, posthumously, as the first recipient, in tribute to his contributions to the aerospace industry over 60 years. 📚
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Aerospace Eyes ‘Brexiteer Boris’

Britain's aerospace industry has cautiously welcomed the appointment of new Prime Minister Boris Johnson but remains worried about the threat of a “no-deal” exit from the European Union. During his leadership campaign, Brexiteer Johnson repeatedly insisted Britain would exit the EU on Oct. 31, regardless of the impact on its economy.

Concern about the potential of a “hard” Brexit, a nightmare scenario for aerospace, prompted companies to shell out hundreds of millions of pounds on buffer stocks and contingency plans to maintain supply continuity in the run-up to the original Brexit deadline of March 29.

An exit from the EU without a deal would result in increased customs checks at UK ports, potentially delaying time-critical production by aerospace manufacturers. It could also invalidate approvals, licenses and certifications issued by the UK Civil Aviation Authority and other organizations.

“The threat of a no-deal Brexit on Oct. 31 is creating uncertainty for industry that is holding back growth and constraining investment,” says Paul Everitt, CEO of UK aerospace and defense trade association ADS.

DEFENSE

Sweden is partnering with the UK on development of technology for future fighters, the two countries signing a memorandum of understanding on joint studies to firm up requirements and establish the industrial base for a potential future program (page 16).

The U.S. is removing Turkey from the F-35 program after it took delivery of a Russian S-400 air defense system. The economic impact is an estimated $9 billion for 10 Turkish suppliers (page 32).


Boeing has informed the U.S. Air Force it will not compete for the Ground-Based Strategic Deterrent program to replace the Minuteman III ICBM under the current acquisition approach, potentially leaving Northrop Grumman as the only bidder.

Commercial operators Grand Sky Development and Tenax Aerospace are the first announced customers for Northrop Grumman's Firebird optionally piloted surveillance aircraft. Deliveries begin in 2020.

Portugal’s government on July 11 approved an order for five Embraer KC-390 airlifters valued at €827 million ($922 million). Deliveries are due to begin in 2023, to replace Portugal's C-130H Hercules.

Karem Aircraft has spun off a new company, with $25 million backing from South Korean industrial conglomerate Hanwha Systems, to develop its Butterfly electric vertical-takeoff-and-landing air taxi.

XTI Aircraft has signed a deal to use the General Electric Catalyst turboprop as the core of the hybrid-electric propulsion system for its TriFan 600 vertical-takeoff-and-landing business aircraft.

Package delivery giant UPS is anticipating FAA Part 135 air carrier certification this fall to operate a commercial drone delivery service called UPS Flight Forward.

Virign Orbit’s Boeing 747-400-based air-launch system is part of the UK Defense Ministry’s Project Artemis to loft a small-satellite constellation into low Earth orbit beginning in late 2020. The spacecraft will be built in the UK by Airbus subsidiary Surrey Satellite Technology.

Europe’s Galileo satellite navigation system suffered a weeklong service outage July 11-18 after a malfunction in its ground infrastructure affecting the calculation of time and orbit predictions.
India launched its second lunar exploration mission, Chandrayaan-2, on July 22 on a GLSV Mk. 3 from Satish Dhawan Space Center on Sriharikota, becoming the fourth country after Russia, the U.S. and China to attempt to land on the Moon.

Propelled by sunlight, The Planetary Society’s crowdfunded LightSail 2 spacecraft began orbit-raising using solar sailing for the first time on July 24 after deploying its 32-m² (344 ft²) aluminized Mylar light sail.

Made In Space is to demonstrate robotic manufacturing and assembly in low Earth orbit under a $73.8 million NASA contract. The Archinaut robot is planned for launch no earlier than 2022 on a Rocket Lab Electron from New Zealand.

The April 20 ground-test accident that destroyed a SpaceX Crew Dragon capsule was caused by a design flaw that allowed a liquid slug of oxidizer for the inflight and abort system engines to slam into a valve, causing it to fail and trigger an explosion (page 41).

NASA is to sole-source the Minimal Habitation Module for the planned lunar-orbiting Gateway to Northrop Grumman, saying its offering, based on the Cygnus cargo capsule, is the only proposal that can meet the goal of returning astronauts to the Moon by 2024.

U.S. helicopter operators face a “deadly threat” as they head for the highest fatal accident rate in more than a decade, warns the U.S. Helicopter Safety Team (USHST). After suffering 27 fatalities in 15 accidents in the first half, the industry is projected to end 2019 with a rate of 0.76/1 million flight hours versus the reduction to 0.61 targeted by USHST.

80 YEARS AGO IN AVIATION WEEK

“Across Europe in 4 hours in British Airways Lockheeds,” proclaimed an ad from Lockheed Aircraft Corp. in our August 1939 edition. The company noted that its transports had helped British Airways nearly double passenger traffic in just two years. “British Airways provides the fastest service from London to the capitals of Europe. Travelers can reach Stockholm, Budapest and Warsaw in seven hours, Brussels in 1 ½, Frankfurt in 2 ½, Hamburg in 3 and Berlin in 3 ½.” But it would be a short-lived hurrah for European air travel. The UK declared war on Germany after the Nazis attacked Poland on Sept. 1, 1939, setting off World War II. Lockheed would remain in the commercial aircraft business for another four decades before exiting in 1982.
THE EARLY 2010S WERE GOOD

years for Russian aircraft manufacturer Sukhoi and its new jetliner, the Superjet. In 2011, low-cost Mexican airline Interjet ordered 30 and gave the program a flagship Western customer. The following year it received European Aviation Safety Agency certification, allowing it to operate in Europe. And in 2016, Irish airline CityJet became the first Western European operator.

Its fortunes changed considerably since then, due to the aircraft’s poor dispatch reliability, inferior customer support and lack of maintenance facilities. In March, 15 of Interjet’s 22 Superjets were out of service, and it now plans to replace them with A320s. CityJet is also returning Superjets after wet-leasing its aircraft to Brussels Airlines, which canceled 92 Superjet flights over just a 22-day period. After the recent crash of Aeroflot Flight 1492, even Russian operators and politicians are questioning its viability. The Superjet saga is the latest example of a new jetliner OEM falling short in customer support. It turns out the largest entry barrier to the jetliner business isn’t capital, technology or manufacturing prowess; it is customer support and its companion—design for reliability.

This is why the recent Mitsubishi Aircraft Corp. deal to purchase the Bombardier CRJ program makes so much sense. Mitsubishi not only eliminated a competitor and gained access to regional airline operators, but it also acquired Bombardier’s customer-support assets, including its West Virginia and Tucson, Arizona, maintenance facilities as well as 900 customer-support and maintenance personnel. This will provide instant presence and credibility as it tries to sell its scope-compliant SpaceJet to North American operators. The deal also addresses a crucial gap created by the Boeing-Embraer joint venture. In 2011, Mitsubishi entered an agreement with Boeing to provide 24/7 customer support, including spare parts provisioning, service operations and field services. It is hard to envision Mitsubishi depending on its primary rival for these crucial services, so it must now stand up its own customer-support function. The Bombardier deal doesn’t address every gap, but it does considerably derisk the customer-support challenge.

Ironically, Mitsubishi is following the same path as Bombardier, which purchased De Havilland from Boeing in 1992. Bombardier was then a business jet manufacturer preparing for the CRJ’s entry into service with airlines. The purchase of De Havilland brought crucial customer-support capability, which underpinned the program’s eventual success.

Customer support is a key and underappreciated strength in the Airbus-Boeing duopoly. Boeing has always had superb customer-support capability. A recent survey by Inside MRO, Air Transport World and AeroDynamic Advisory ranked Boeing No. 1 out of 41 commercial OEMs in customer satisfaction for aftermarket support. This was the second consecutive year that it finished on top.

What about Airbus? Customer support was a weakness in its first two decades, but by the mid-1990s it had closed most of the gap with Boeing. Now it is world-class, and it isn’t surprising that it ranked No. 2 in the aforementioned aftermarket survey. Both Airbus and Boeing recognize that they aren’t just selling jetliners—they are selling 24/7 aircraft uptime, availability and support—anywhere on the planet. This requires a unique combination of people, processes, infrastructure and culture and takes decades to create.

This begs the question of what other new entrants—including Avic, Irkut and Comac—will do to address the customer support imperative. Avic may be preparing to roll out an MA700 prototype, but it has yet to outline a credible customer-support strategy. Its experience with the notoriously unreliable MA60 isn’t encouraging. Irkut faces the same issues as Sukhoi and will be hard-pressed to show it can deliver 24/7 uptime to MS-21 operators.

Comac also will face the same quandary when the C919 enters service. One of its first actions after its founding was to build a large and impressive customer-support building in Shanghai. But like Avic, its customer-support plan—particularly outside of China—is unclear. Comac was rumored to be in discussions to purchase Bombardier’s Commercial Aircraft business several years ago but was unable to close the deal. This might have been its best chance to accelerate its customer-support development. It will need Western partners and several decades of development if it hopes to overcome the jetliner industry’s biggest challenge.

Contributing columnist Kevin Michaels is managing director of AeroDynamic Advisory in Ann Arbor, Michigan.
THERE WERE SIX OF THEM AROUND the campfire, savoring and sharing their
long weekend of camping, fishing, hiking
and flying in the backwoods of northwest
Montana. Their gathering place was Schafer Meadow, an
airstrip in a designated wilderness area, operated
by the U.S. Forest Service (USFS), open to the public
and, fittingly, surrounded by tall trees. The standing
cautions to visiting pilots: Watch for horses or big game
on the 3,200-ft. grass runway.

The campfire conversation flowed to their collective
appreciation for the privilege of alighting in hallowed
places of nature and taking in the abundance, the quiet,
the glorious isolation made accessible on light-
plane wings. They knew their experience was
rare in the world and that it had to be preserved.

Their consensus: Someone would have to speak for and defend such remote strips. Why
not assume the role themselves? The question
lingered as they slipped into their sleeping bags.
And, as John McKenna—one of the six—recalls,
while some bottled spirits might have helped an-
imate the previous evening’s conversation and
conclusion, come dawn with cups brimful of cowboy coffee and the morning air perfumed with
woodsmoke, the subject and solution held firm.

And thus in that summer of 2003 the Recre-
tional Aviation Foundation (RAF) was born. McKenna and the other founders readily admitted
each other that they were clueless as to how to
accomplish their goal, but the group was sure that
their intent—to save and secure wilderness air-
fields for all—was a valid, even urgent mission.

They soon came to appreciate that the larg-
est landowner by far in the U.S. was the fed-
eral government, primarily through three agencies—the
USFS, National Park Service and Bureau of Land Man-
agement. Those three entities control some 525 million
acres of primarily Western public land, or more than
twice the total acreage of New England and all Eastern
seaboard states combined.

To help facilitate entry and movement by their rang-
ers, managers and scientists within those vast reach-
es of forest, plains, mountains, lakes and streams, the
agencies have created an estimated 750-800 airstrips,
all ready RAF targets for preservation and public use.

McKenna, now RAF’s chairman, says a pivotal mo-
moment for his then-infant organization came with a phone
call from Ben Ryan. A World War II P-38 pilot and re-
tired petroleum geologist, Ryan invited McKenna to vis-
it him and his wife, Butchie, a wartime Army nurse, at
their 160-acre wilderness home bordering Glacier Na-
tional Park and to land on their 2,500-ft. grass strip, one
they’d cleared themselves years earlier.

As McKenna recalls, he and Ryan discussed their
mutual love of backcountry flying and the RAF’s goals
for about 15 min. when the old fighter pilot turned to him
and said: “I think I’d like to give you this place.” With

that, the RAF became an airport owner and committed
to the conservation of both public and private lands—
the latter hosting hundreds more such strips.

Since then, the RAF has helped to restore, secure
or develop some 50 backwoods airstrips. Furth-
more, it has worked diligently with state legislatures
to protect the owners of private facilities that are
open to the public so they cannot be held liable for
any mishap involving visiting aircraft.

In so doing, the RAF has attracted an enthusiastic fol-
lowing and partnered with the Nature Conservancy on
several projects. Despite the fact that at its founding the organization was focused on the Northwestern states,

Woodsmoke and Wings
The mission: Save and secure wilderness airstrips

William Garvey is Editor-in-Chief of Business & Commercial Aviation
FOR AN X-PLANE, NASA’S X-59 QueSST supersonic low-boom flight demonstrator is under unusual schedule pressure. Industry needs data from the aircraft’s first community-acceptance flights by 2024 if it is to stay on track to establish long-awaited noise standards permitting supersonic flight over land.

Without data on what level of sonic boom the public would find acceptable, civil supersonic aircraft could continue to be prohibited from flying above Mach 1 over land. This would limit the economic viability of the new-generation supersonic transports industry aims to deliver within the next 5-10 years.

The schedule is tight. NASA expects Lockheed Martin’s Skunk Works to fly the X-59 from Palmdale, California, late in 2021, but it could slip into early 2022. Envelope expansion, acoustic validation and initial public-response data collection flights will follow at Edwards AFB in California.

NASA needs to conduct the first community-acceptance flights beyond the Edwards test range in 2023, likely over a location in Southern California, if it is to meet its commitment to deliver an initial dataset to the International Civil Aviation Organization (ICAO) by the end of 2024.

That deadline is set by the need to collect and analyze the data before the 13th meeting of ICAO’s Committee on Aviation Environmental Protection (CAEP) early in 2025. CAEP is developing a standard for en route noise that will enable aircraft to be certified for supersonic flight over land.

This has already been a long road. ICAO has been working on sonic boom—which regulators now prefer to call en route noise as advances in aircraft design have reduced the boom to a thump—for 15 years, and it will be another 10 years before the final certification standard will be ready.

The reason it is taking so long is complexity. Existing regulations for certifying aircraft landing and takeoff noise involve measuring sound levels at the ground and then, by analysis, working back to the source noise and propogating that through a reference atmosphere to produce the data required by the certification authorities.

That will not work for sonic boom. “As the boom propagates through the atmosphere, it loses features. We can’t backtrack to the source, then propagate that noise under reference conditions,” says Robbie Cowart, director of supersonic technology development at Gulfstream. “Certification procedures require measurements at reference conditions,” he told the American Institute of Aeronautics and Astronautics Aviation conference in Dallas in June.

Close to an aircraft cruising supersonically, the sonic signature is a ragged mix of shock and expansion waves. Farther from the aircraft, at mid- and far-field, features start to coalesce and become fewer, but then the boom enters the Earth’s boundary layer, where low-altitude turbulence reintroduces high-frequency content to the signature, even causing localized focusing and strengthening of the boom.

“With turbulence, you can get a radically different signature just 20 ft. away,” says Cowart. This raises the question of where the boom should be measured: at the ground, above the turbulent layer or at a mid-field altitude? There is also the issue of which noise to certify—the cruise boom that NASA has set out to reduce or the focused boom that is generated when the aircraft accelerates, decelerates or maneuvers? And do you measure noise only under the aircraft’s track or across the entire 20-mi.-wide boom carpet?

When an aircraft is designed to minimize the under-track boom, it can increase the noise off-track and off-design. “How do we do this in a uniform, robust and consistent manner?” asks Cowart. “How do we measure boom and keep it economically feasible? We have to think about economic reasonableness. If we have to spend 20% of our flight-test budget on measuring en route noise, that’s not reasonable.”

These are just some of the issues being tackled by CAEP experts as they work to develop the first-ever certification standard for sonic boom. But to ensure a sustainable return to supersonic air travel, the most critical step remains determining what level of en route noise the public will deem acceptable.

For that, NASA is under the gun to begin collecting community-response data by 2023 and to complete 4-6 flight campaigns across the U.S. by the end of 2025. “It’s a very tight schedule,” acknowledges Dave Richwine, deputy program manager for technology. The X-59 is an X-plane program with a deadline.
An Icon at NASA Falls

A NASA legend dies and a protege is sidelined

Kennedy's 1961 challenge to land astronauts on the Moon in eight years, Kraft left his post as flight director to be a program manager and mission architect, eventually becoming director of the Manned Spacecraft Center (later renamed Johnson Space Center). Kraft served in that role until he retired in 1982 as NASA began what became more than 30 years of space shuttle operations.

The challenges Kraft faced were different from what vexes NASA today. The agency is more focused on cost and safety than flight schedules. It has vastly more sophisticated technologies at its disposal and increasing numbers of universities, companies and government agencies to draw upon as partners.

Yet NASA remains structured for Apollo-class efforts, with nine field centers, the Jet Propulsion Laboratory, a headquarters in Washington and seven test and research facilities in several states. The agency employs more than 17,000, half now over age 50, and supports thousands more as contractors.

So far, NASA has skirted base realignment and closure-type activities, initiatives the U.S. implemented in 1988-2005 to improve Defense Department efficiency after the Cold War. But the times may be a-changin'.

On July 10, another Kraft protege, Bill Gerstenmaier, was ousted as associate administrator of human exploration and operations, a position he held for 14 years under five NASA administrators. Gerstenmaier, 64, is largely credited as the steadying hand and driving force in the face of shifting political winds that have repeatedly grounded all destination-driven, deep-space exploration initiatives since Apollo.

Gerstenmaier led teams that maintained low-Earth-orbit human space operations—the space shuttle, the International Space Station—and oversaw technology developments (SLS, the Orion deep-space capsule) not considered mission-specific. But another U.S. presidential election will take place before the SLS flies in 2021. NASA's plan now is to land astronauts on the Moon in 2024, just three years later, provided Congress approves a $20-30 billion plus-up, spread out over the next five years.

Toward that end, NASA Administrator Jim Bridenstein reassigned Gerstenmaier and his deputy Bill Hill, saying it was time for new leadership. It remains to be seen whether the move was cosmetic, seismic or somewhere in between. But whoever helms NASA's human spaceflight program will have more than one legend to live up to.
Over the past 50 years, Safran’s long-game strategy to become a leading engine provider has paid off handsomely in the commercial, military and helicopter sectors. But entering the business jet market with its Silvercrest engine has proved the hardest nut to crack and, for the moment at least, looks set to remain out of reach.

Dogged by technical issues, a protracted development schedule and launch platforms with uncertain prospects, the company’s exhaustive efforts to push the Silvercrest into service make even Snecma’s decade-plus campaign to sell the CFM56 in the 1970s pale in comparison. The latest and possibly deadliest blow in the saga came on July 17, when Textron Aviation revealed it had terminated its contract with Safran to supply engines for the Cessna Citation Hemisphere.

The decision marks the third time in four years that the 9,500-12,000-lb-thrust Silvercrest turbofan has been dropped from an aircraft program, and it means the engine effort is effectively in limbo. The first occurred in 2015, when Cessna switched from the Safran engine to the Honeywell HTF7700 for the redefined super-midsize (SMS) Longitude. The second, and far more painful loss, came in late 2017, when Dassault abandoned the Silvercrest-powered Falcon 5X, the 5,200-nm-range aircraft that had evolved from the French aircraft maker’s initial SMS studies. Even though the Silvercrest launched first in 2012 with the Longitude, it was its victory in the contest to power Dassault’s prestigious SMS project that really put Safran’s new engine on the map. Having overturned Rolls-Royce’s RB.282 and beaten the competition from General Electric, Honeywell and Pratt & Whitney Canada (P&W), the win appeared to signal Safran’s arrival as a promising new player in the field, with an all-new engine in the equally new 10,000-lb-thrust class range.

Yet development issues, particularly with the high-pressure (HP) compressor, continued to delay the program. The problems hit a peak in 2017 during tests on Safran’s Gulfstream II flying testbed, when the company uncovered compressor acceleration, deceleration and stall issues at high-altitude and low-speed conditions.

Unusually for an engine in this higher thrust range, the HP compressor combines a four-stage axial unit with a single centrifugal stage, though Safran has maintained all along that the issues are with the axial and not the centrifugal section. Though some surge margin could be recovered by control-software changes and variable stator-vane rescheduling, Safran came to the grim realization that more serious and time-consuming flowpath modifications would be required.

The news did not sit well with Dassault, which had already been forced to postpone the 5X’s advertised entry-into-service date to 2020 from 2017. Eventually, facing the prospect of a further slip beyond 2020, Dassault canceled the program and launched a stretched Falcon 6X design in its place, powered by P&W’s PW800.

Despite its embarrassing position and the acrimonious parting of the ways with Dassault that followed, Safran remained confident that the engine would fare better on Cessna’s Hemisphere—a large-cabin jet for which it was selected by Textron in 2016. Although the same baseline problems persisted, and even led to Textron suspending Hemisphere development in early 2018, it appeared prospects for the program were brightening significantly late last year when fractional ownership provider NetJets ordered up to 150 aircraft.

**Guy Norris** Los Angeles and **Thierry Dubois** Lyon

**PROPULSION**

**STALLED STRATEGY**

**ROOT CAUSE OF ENGINE ISSUES IS INSUFFICIENT SKILLS RETENTION, SAYS ENGINE-MAKER**

**HEMISPHERE MARKS THIRD LOSS FOR SILVERCREST**

**Compressor problems cropped up in flight tests on Safran’s Gulfstream II flying testbed.**
However, this was not to be: In July, Textron again halted the Hemisphere program, citing Safran’s failure to demonstrate the “required performance” with the Silvercrest. Although Safran had tried to convince Textron it was making progress with the redesigned compressor, the pace or degree of improvement was insufficient, according to Textron CEO Scott Donnelly. “We just had a timeline and said, ‘Guys, we need to step back here and commit resources in other places for now,’” he says.

“We determined that the engine has not yet demonstrated the performance required for the aircraft design, and we have put the program on hold. Any decision to revisit the program in the future will depend on the state of the market, proven engine performance and a competitive landscape at that time,” says Donnelly. Aside from market conditions, Textron also faces pressure to complete other programs and is redirecting resources from the Hemisphere to support completion of the Longitude, Cessna 408 SkyCourier and Denali turboprop.

The news appeared to dumbfound Safran, as the modified engine had performed well in ground tests conducted in May-June 2018. “We had committed, in 2018, to validate the HP compressor’s performance and operability,” says a Safran spokesperson. “Results have exceeded expectations,” and development “has made the intended progress over the past 12 months,” the spokesperson adds.

Apart from being a blow to Safran’s plans to diversify its portfolio, the news also kills off its ambitions to use the program as a showcase for its broader development capabilities as well as to use the Silvercrest for the potential development of a new small regional engine core. Safran also intended to leverage its large commercial engine experience and bring new maintenance standards to business aviation.

Yet even though persistent compressor issues plagued the program, has its demise uncovered deeper systemic issues within Safran? Certainly, the repetition of technical issues at a seasoned engine manufacturer such as Safran seems perplexing. The answer, it seems, is linked to skills retention. “It is not very often that we do an engine development from A to Z,” Safran CEO Philippe Petitcolin tells Aviation Week. “In the meantime, some design engineers retire. We certainly must better maintain, over time, technology skills for each engine component.”

Safran, meanwhile, says that even without a prospective application, work will continue on the engine as a research and technology asset. It adds that upcoming tests are planned to “further confirm engine improvements and complete overall engine performance and durability validation.”

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The Safran Silvercrest Roller Coaster
Program Ups and Downs

2006 Launch of the Snecma SM-X core demonstrator program
2008 Silvercrest core testing concludes successfully
2009 Dassault reopens engine contest for Falcon SMS (later 5X)
2010 Cessna launches Citation Longitude with Silvercrest engines
2012 Dassault launches Falcon 5X with Silvercrest engines
2013 Dassault terminates Falcon 5X program, blaming Silvercrest
2014 Cessna terminates Silvercrest contract with Safran
2015 Safran flies Silvercrest on modified Gulfstream II testbed
2016 Cessna terminates Silvercrest for Hemisphere jet
2017 NetJets announces optional order for 150 Hemispheres
2018 Cessna launches Citation Longitude with Silvercrest engines
2019 Dassault redefines Longitude, drops Silvercrest
2020 Safran says the upgraded core has exceeded expectations in testing.

Source: AW&ST Research
With the July announcement of Sweden as the first of several “like-minded partners” for Britain’s Tempest, the UK system has become an international venture and a direct competitor to the Franco-German-Spanish Future Combat Air System (FCAS).

“We believe that Europe can afford two separate combat air programs,” former British Defense Secretary Penny Mordaunt said in a parliamentary statement on July 22, adding that the FCAS project simply “does not meet the objectives laid out in our [combat air] strategy.”

The memorandum of understanding (MOU) between the UK and Sweden paves the way for joint studies that will firm up mutual requirements and establish an outline plan for the industrial base for a potential future acquisition program. A report on the joint studies’ results is due next fall.

Sweden’s biggest aerospace and defense company, Saab, will be a key player after a year of “deepening dialog,” the term BAE Systems has used to describe the initial feasibility studies undertaken over the last year by the UK and Sweden.

However, Saab will not join Britain’s Team Tempest—a consortium of industrial and government entities—but will instead work directly with the different team members including BAE Systems, Leonardo, missile manufacturer MBDA and aero-engine company Rolls-Royce.

The timing of the report may be critical. The pace of the Tempest, its associated Future Combat Air System Technology Initiative (FCAS TI) and the UK’s own acquisition initiative to bring a Eurofighter Typhoon replacement to the front line by 2035 demand at least one or two well-developed concepts that will be ready to enter the torturous government formal procurement process by the end of 2020.

“Sweden is an ideal partner; few nations work as well together as Sweden and the UK,” said British Defense Procurement Minister Peter Hultqvist, adding that both nations had “recognized each other’s strengths and the need for an equal partnership.”

The UK and Sweden will remain open “for others to join the discussions,” he noted.

The 10-year agreement does not “entail long-term commitments between the countries, but is intended to enable future positions,” the Swedish defense ministry stated.

Micael Johansson, Saab’s deputy CEO, says he expected the partnership to lean on Saab’s experience with “cost initiatives, model-based engineering and digitalization—things we have worked hard on the Gripen.”

“International cooperation is part of Saab’s strategy for growth, and the collaboration with the British industries represents that way of working also with regard to the future,” Saab President Hakan Buskhe said at RIAT.

Technology developed for the future fighter would also be incorporated into both the Typhoon and the Gripen, increasing their capabilities.
FLYING TESTBED

"dialog," the term BAE Systems has key player after a year of "deepening studies." The results are due next fall. Establishing an outline plan for the industrial and market studies undertaken over the last year by the UK and Sweden. However, Saab will not join Britain’s Tempest, with some valued at hundreds of millions of pounds. Mordaunt said in a parliamentary statement on July 22, adding that the future of Sweden as the first of several companies to enter into the Tempest program is critical. The pace of the Tempest, its industrial partners including BAE Systems, Leonardo, missile manufacturer MBDA and aero-engine company Rolls-Royce. Team members include the British defense ministry stated.

"It is of mutual interest to partner with an actor who is operationally and industrially skilled," Swedish Defense Minister Peter Hultqvist said, adding that the Tempest concept model similar to the F-22 Raptor and the Chinese J-20. Engineering is the future of the Tempest--at least compared to previous procurement programs— is Casnet, a secure classified network linking the major industrial partners in Team Tempest so that secret information can be shared and meetings can be conducted securely online. "The critical factor in this program is time," says Holmes. "We have demonstrated toolsets in our design, as well as the ability to iterate up to 20 times faster than we have in the past in various areas," explains Holmes. "The advances in computational techniques and model-based engineering means that our ability to explore a range of concepts is vastly increased."

There are nearly 80 classified projects associated with technologies that are directly associated with the Tempest, with some valued at hundreds of millions of pounds. Mordaunt said in her statement that the team is on track to deliver "17 European firsts and seven world-firsts," noting Rolls-Royce’s work on embedding an electrical generator into the core of an Adour engine. Bancroft says Leonardo is working closely with Rolls-Royce to define the electrical and cooling requirements for a future powerplant and that directed-energy weaponry is a key consideration in the program.

The British Defense Ministry recently confirmed it will provide further funding for the development of three additional directed-energy weapon demonstrators for lasers and radio-frequency-based systems.

At the Air Tattoo, BAe Systems revealed it has been researching wire-and-arc additive manufacturing of major structural components for a future platform. As an experiment, the company produced a structural member for the Eurofighter Typhoon. The long-lead item, which is normally forged then finished, must be ordered as far as 100 weeks in advance, however, the additive manufacturing process builds the component in just 100 days with considerably lower cost and material wastage.

The company also has been exploring weapon bay designs, showing off a rotary design for the unclassified Tempest concept model similar to one on the Blackburn Buccaneer subsonic maritime strike aircraft that entered service in the 1950s. The rotating design features three sections: one flush with the fuselage to preserve the aircraft’s low-observability characteristics and the other two able to each carry a pair of Meteor air-to-air missiles.

Two side bays flush with the air intake would be able to launch short-range air-to-air missiles, as do the F-22 Raptor and the Chinese J-20. Engineers are studying options for bay opening times and looking at the harmonic effects of airflows over shallow and deep weapon bays. The UK is one of the few European nations with experience in producing aircraft with internal weapon bays, but this experience does not extend to releasing weapons at supersonic speeds.

In the Royal Air Force’s Rapid Capability Office, the organization’s Air Information Experimentation (AIX) program is taking the first steps toward a combat cloud. A project called Deckard has produced, in just two months, a cloud-based program sharing information on the UK airspace picture to support air policing. Deckard has been introduced as part of a wider program called Nexus, which hopes to share this information across other platforms.

Britain is continuing its search for additional partners, nations “whose strategic objectives align with our own, including the determination to reduce costs,” Mourdant says.

“We recognize that in an effective
and efficient collaboration, there will be an optimum number of partners, which may include those outside of Europe,” she adds.

Challenges remain, however. New Prime Minister, Boris Johnson is a Brexiteer looking to help Britain negotiate an exit from the European Union at the end of October, deal or no deal. A “hard” Brexit could do serious harm to the British economy. However, Sweden’s defense minister says he is not concerned: “Brexit or not, we have this cooperation, and we will make it deeper,” Hultqvist says.

Manufacturing Process Is Key for British Low-Cost UCAV Concept

MOSQUITO PLANS TO FLY A TECHNOLOGY DEMONSTRATOR IN 2023

PLATFORM WOULD PERFORM STRIKE, ISR AND ELECTRONIC ATTACK MISSIONS

Tony Osborne RAF Fairford, England

The Royal Air Force (RAF) has lifted the veil on its vision for fleets of low-cost, unmanned aircraft that could go on to accompany its fourth-, fifth- and sixth-generation fighters into operations.

In an approach similar to the U.S. Air Force’s adoption of the Kratos XQ-58 Valkyrie for its Skyborg program, Australia’s Boeing-led Airpower Teaming System and the so-called remote carriers proposed for use with the Franco-German Future Combat Air System, the RAF is looking for a platform that can perform a wide range of missions either independently or through manned-unmanned teaming. But the RAF hopes to do it with a platform costing 1/10th of current combat aircraft, developed in one-fifth the time.

The project answers a call from the RAF’s Chief of Air Staff, Air Marshal Stephen Hillier, to “arrest the rising cost of each generation of combat aircraft, not by cutting numbers of platforms, but by achieving both mass and cutting-edge technology at the same time.”

Work on the Lightweight Affordable Novel Combat Aircraft (LANCA), first revealed by Aviation Week in March 2018, called on bidders to offer proposals for a low-cost unmanned combat air vehicle (UCAV) demonstrator in a first phase of the program.

LANCA has its origins in studies carried out by the Defense Science and Technology Laboratory (DSTL) in 2015, looking at lower-cost approaches to providing air combat capabilities. The project was subsequently brought into the purview of the RAF’s Rapid Capability Office (RCO) and made part of the wider Future Combat Air System Technology Initiative (FCAS TI), albeit with DSTL leading the program.

Nine companies and consortia entered proposals for Phase 1 of LANCA, valued at £4.8 million ($6 million), which also included larger players including BAE Systems and missile manufacturer MBDA. Three of those were downselected in April this year to continue to the second phase of the project called Mosquito, expected to be worth £30-50 million, which will see one or two of the proposals further matured into a technology demonstrator and leading to a limited flight-test program in the UK.

Among those chosen was UK-based Blue Bear Systems Research, Boeing Phantom Works International (working with Marshall Aerospace and Cranfield University) and Team Blackdawn, a consortium of aerospace consultancy Callen-Lenz working with Bombardier Belfast and Northrop Grumman UK.

None of the companies have revealed details of their designs, although the Boeing proposal may lean on the work already underway in Australia and unveiled earlier this year.

One of the aims is for the Mosquito platform to be free of International Traffic in Arms Regulations, smoothing potential exports.

“This is not another Taranis project,” Peter Stockel, the LANCA/Mosquito lead at DSTL, said at the Royal International Air Tattoo in reference to the £180 million UCAV program. “This is about proving the process for design and manufacturing . . . . We are as interested in the manufacturing process as the aircraft.”

Mosquito aims to have a demonstrator platform, which Stockel expects to be slightly larger than a BAE Systems Hawk jet trainer, flying by 2023, helping to generate evidence that could inform potential future requirements. The budget could even allow for a fly-off.

DSTL and the RCO have not proposed a powerplant, but Stockel says the system will likely use low-cost business jet engines, which will allow for transonic performance to keep up with manned fighters in cruise but also allow for longer endurance for intelligence, surveillance and reconnaissance (ISR) missions. The Mosquito may also leverage swarming techniques developed by DSTL through its Fractionated Delivery for Integrated Effects studies.

The Mosquito is not linked, however, to RAF plans for a swarming drone squadron capable of confusing and overwhelming enemy air defenses, announced by former Defense Secretary Gavin Williamson in February, and which also sees Blue Bear playing a key role. Hillier announced that a new experimental unit, 216 Sqn. would be reformed to bring the swarming drone capability to the front line.

It will be left to the bidders to propose a model for their Mosquito’s operation, including whether it is treated like a reusable munition and stored for long periods until required, with perhaps a handful retained for training. Bidders are also being encouraged to make use of the Defense Ministry’s open-architecture Pyramid software, currently in development, as well as study options for control.
The Royal Air Force (RAF) will explore the feasibility of fielding a locally designed hypersonic weapon within four years and also invest £10 million ($12.4 million) to develop and test military applications for the hypersonic-propulsion systems in development by UK-based Reaction Engines, senior officials said July 17.

The announcement moves the UK into the exclusive club of nations vying to develop hypersonic weapons and aircraft, joining China, France, Japan, Russia and the U.S. Although the RAF’s commitment stops short of a formal program of record, the moves will likely provide a boost for weapons-maker MBDA UK and the UK propulsion industry, including Rolls-Royce, as the RAF studies weapons and platform options for the Team Tempest next-generation fighter project.

The RAF’s Rapid Capabilities Office is pursuing the possibility of fielding an air-launched weapon with Mach 5 speed by 2023, said Air Vice Marshal Simon Rochelle, chief of staff capability. “I have challenged my team—and we are working on this with some other people at this moment in time—to see whether or not we can generate a Mach 5 capability in four years,” Rochelle said at the Air and Space Power Conference in London.

During his remarks, Rochelle displayed a ramjet-powered missile that appeared to be based on the Hypersonic Air-breathing Weapon Concept designed by Lockheed Martin. But Rochelle clarified later in a brief interview that the study is focused on UK-designed technology. He declined to elaborate on possible propulsion systems such as ballistic missiles, ramjet-powered cruise missiles or boost-glide reentry vehicles.

The focus of the study is to identify an “affordable” solution, Rochelle said, again without elaborating. The RAF has no history of developing hypersonic air-breathing cruise missiles, but as one of six national consortium members that developed the ramjet-powered, Mach 4 Meteor, MBDA UK may have technology that can be scaled up to a Mach 5-speed vehicle.

Justin Bronk, a research fellow at the Royal United Services Institute, also said on the sidelines at the same event that he would guess that classified programs provide the RAF with the aerodynamic data required to scale up and design a Mach 5-class weapon rapidly.

Such a weapon would provide extended range and speed as the UK seeks to make its fourth-generation fighter fleet relevant for decades more, even as the RAF continues to receive the Lockheed Martin F-35B and embarks on development of a next-generation fighter under the Tempest project.

In his remarks, Rochelle noted that fourth-generation fighters will still account for 80% of NATO’s combat fleet by 2030, even as an increasingly sophisticated array of integrated air defense systems forces such aircraft to operate at much longer distances from their presumptive targets.

“If we can imagine a machine that is firing thousands of affordable Mach 5 weapon system back into the fight,” Rochelle said. “It makes sure that [fourth-generation] aircraft stay leading-edge, and not waiting for Day 7 of combat.”

The RAF has also launched a two-year development-and-test program with Reaction Engines, which has designed an air-breathing, hypersonic engine called SABRE (for Synergetic Air-Breathing Rocket Engine) for future civilian manned aircraft.

The partnership is exploring how to apply the SABRE technology to existing supersonic engines and potential future platforms under consideration by Team Tempest, Air Chief Marshal Stephen Hillier, the RAF chief of staff, said at the same event.

One goal is to identify potential technologies such as the SABRE inlet precooler that could be applied to make supersonic engines, such as the Rolls-Royce EJ200 for the Eurofighter Typhoon, more efficient.

Just as worth noting is the potential for a hypersonic engine to provide the same boost for cost as a smaller Seneca Air-breathing Weapon Concept engine, according to Hillier. “It is not an affront to anything,” he said.

Another goal is to evaluate potential hypersonic options for next-generation platforms. The Tempest project is not formally pursuing the design of a hypersonic aircraft, but it is possible that the family of systems envisioned by the program may have elements that require more than supersonic speed.

An RAF press release described the £10 million investment in hypersonic propulsion as one part of the “technologies being developed in parallel with Project Tempest.”

“We will work through with the engine and find out, OK, what is its potential, and then—alongside Tempest—what do we want that platform to be, and is there a proper congruence between the two?” Hillier said.

The RAF plans to open a center of excellence focused on hypersonic technology, with Tempest partners BAE Systems and Rolls-Royce participating.
Sweden Is Relearning Cold War Basing Skills

Tony Osborne London

In the face of a more advanced and menacing Russian threat from across the Baltic Sea, Sweden is having to relearn the old skill of dispersed basing.

The principle is simple: Dispersing the air force means it cannot be destroyed in a single, coordinated attack such as Israel achieved against Egypt in the 1967 Six-Day War.

During hostilities, Swedish Air Force fighters would fly off into the hinterland to carry out missions from highway strips and general aviation airfields, supported by a handful of personnel and conscripts.

A well-trained team can refuel and rearm an aircraft often in less than 15 min., even in the coldest of winters. Sweden's fighters were designed to operate to and from austere airfields, with minimal ground equipment and support. Over the years, the air force's basing model has adapted to new threats, with the last Bas90 system increasing resilience by using dozens of strips scattered throughout the country.

However, since the end of the Cold War, there was less need for dispersed basing, and the framework faded away as the country’s armed forces were focused on closer interoperability with NATO and more overseas missions such as supporting operations in Afghanistan and Libya.

But the reemergence of a threat from Russia following its annexation of Crimea increased activity in the Baltic, and the siting of advanced weaponry in Kaliningrad has prompted Sweden to focus again on national defense. Spending is on the rise, and capabilities that were deemed unnecessary after the Cold War are being restored.

Two years ago, conscription was restarted after a seven-year hiatus, and some 4,000 personnel will undergo basic military training this year. The armed forces have also reequipped themselves with batteries of coastal defense anti-ship missiles. At the beginning of July, Stockholm took the decision to reinforce the air defenses of Gotland, one of Sweden's Baltic islands, with additional air defense systems.

“We used to do [dispersed basing] a lot during the Cold War, but we reduced our ambitions,” Maj. Gen. Mats Helgesson, the commander of the Swedish Air Force, said on the eve of the Paris Air Show in June. “In the last five years, and particularly in the last one or two years, we have done a lot of these activities using highways and small airfields in order to be dispersed and protected.”

The reintroduction of conscription is one of the key ingredients that is allowing the air force to restart training for dispersed basing.

“We need conscription, to be able to conduct these dispersed operations,” Helgesson said. Every dispersed aircraft is supported by one or two full-time technicians and a team of conscripted personnel to load weaponry and fuel the aircraft. The aircraft also provide perimeter protection, Helgesson added.

Commanders are developing a new model for dispersed bases that is less reliant on the old highway strips and more focused on existing airfields and auxiliary runways connected to them. The air force’s new basing concept for 2020-35 calls for main air bases, known as O-Bas; so-called side airbases called T-Bas; and auxiliary airfields to be operated in several groups located across the country. Within the airfield groups, there are units taking care of logistics and protection of the aircraft while on the ground. They also need to be able to set up decoys.

One example of a T-Bas would be Jokkmokk near the Arctic Circle, a small airfield with three landing strips connected to it by long taxiways.

“A side base could be able to supply a Gripen operation for 12 or 24 hr., or take care of transport aircraft,” said Helgesson.

The air force expects to use the dispersed bases differently under its new strategy, with pairs of aircraft operating from one location and landing at another once a mission is complete. Sweden’s defense commission, which in May published a white paper on strengthening the country’s defense capabilities into the 2020s, suggests that the bases may also need to be able to receive international support.

The Saab Gripen was designed to operate from short runways and highway strips, known as “vagbas,” that are critical to Sweden’s wartime-survival plans.

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Mystery Missiles?

> SEVEN U.S. HYPERSONIC PROJECTS COVER AIR-, LAND- AND SEA-BASED WEAPONS

> PENTAGON EXPERT’S ONLINE PROFILE POINTS TO EXISTENCE OF TWO MORE PROGRAMS

Steve Trimble Washington

Beyond seven acknowledged projects aimed at developing long-range, maneuvering missiles with a top speed over Mach 5, the U.S. Defense Department is working in classified secrecy on at least two more hypersonic weapon programs, industry officials say.

The mystery of the classified projects—including such details as their development or operational status and any gaps each fills in the Pentagon's unfolding hypersonic weapons architecture—remains unsolved. But a new clue embedded in the LinkedIn profile of a senior Defense Department hypersonic weapons expert may point to the answers.

Greg Sullivan, a well-regarded expert in the high-speed flight community, describes himself on the professional social media platform as an on-site supporter of air-breathing hypersonic weapons to the department's research and engineering arm. Sullivan’s profile also cites his knowledge of “additional hypersonic programs,” which include a nearly comprehensive list of the Pentagon’s acknowledged projects. Intriguingly, his original list also included two additional acronyms representing hypersonic programs: “HACM” and “HCCW.” Shortly after Aviation Week inquired to the Air Force Public Affairs office for details about HACM and HCCW, both acronyms were deleted from the LinkedIn page.

The Air Force does not acknowledge the existence of any program named HACM or HCCW, and no reference to either acronym appears in the military’s public documents, such as budget materials and press releases.

Two sources say they have heard vague references to the existence of a hypersonic program called HACM, but had no details, including what the acronym means. The HCCW program was not known to any sources or analysts contacted by Aviation Week.

The expert hypersonic community is an unusually tight-knit group, reflecting the technology's mostly experimental status for decades, until its recent rise as one of the Pentagon's top acquisition priorities. The existence of two new acronyms has prompted several speculative guesses.

Richard Hallion, a former Air Force chief historian who specializes in the history of hypersonic technology, noted that the acronym HACM could be interpreted broadly to cover almost any type of hypersonic weapon, including scramjet-powered cruise missiles or air-launched boost-glide systems.


The meaning of the HCCW acronym proves even more elusive. For Justin Bronk, a research fellow specializing in airpower at the Royal United Services Institute, one speculative interpretation conforms to his analytical view of a gap in the U.S. military’s weapons arsenal. If the acronym stands for “Hypersonic Counter-Cruise Weapon,” Bronk says, HCCW could be a valuable interceptor specifically tailored against high-speed, air-breathing cruise missiles.

Although the exact role and status of HACM and HCCW are unknown, industry officials have repeatedly said that at least two additional classified programs exist beyond the Defense Department’s seven acknowledged programs. The public list leaves little room for gaps to be filled by new weapons, as they already span air-, land- and sea-launched options and include two different types of boost-glide systems—winged and biconic—and a scramjet-powered cruise missile.

The plethora of planned hypersonic options are intended to serve tactical and strategic goals. On the tactical level, the Pentagon’s war planners will gain a new option for striking mobile missile launchers and countering long-range attacks on the Navy’s surface fleet by an adversary with hypersonic anti-ship missiles. The future U.S. inventory of hypersonic missiles also is...
intended to serve as a deterrent option short of a nuclear response, as adversaries such as China and Russia stock their arsenals with a range of new hypersonic weapons. The Air Force alone accounts for two of the acknowledged hypersonic weapon programs: a boost-glide system with a winged glide vehicle called the Air-launched Rapid Response Weapon (ARRW). Another called the Hypersonic Conventional Strike Weapon (HCSW) relies on a less-risky biconic glide vehicle.

The ARRW, also known as the Lockheed Martin AGM-183A, is based on the Tactical Boost Glide (TBG) program, a risk-reduction effort funded by DARPA. The same winged glide vehicle also is being adapted for ground launch under DARPA’s Operational Fires (OpFires) program. Raytheon says it is developing a more advanced winged glider under the TBG program, which could be fielded as a second-generation version of ARRW.

HCSW, meanwhile, is the air-launched version of a biconic-shaped glider originally designed by Sandia National Laboratories. The Navy and Army are adapting the same original design for the sea-launched Conventional Prompt Strike (CPS) system and the Army’s ground-launched Long-Range Hypersonic Weapon (LRHW).

Finally, Raytheon and Lockheed are each designing different scramjet-powered missiles under DARPA’s Hypersonic Air-breathing Weapon Concept (HAWC) program. Weaponized versions of HAWC are under study by the Air Force and Navy for air and sea launch. One possible gap in the weapons portfolio is the apparent lack of an operational follow-on program for HAWC, even though Air Force officials say the program is slightly ahead of DARPA’s TBG program. The TBG demonstrator is intended to reduce risk for the operational ARRW system, but no such operational follow-on exists publicly for HAWC.

Tom Bussing, vice president of advanced missile systems for Raytheon, acknowledged two hypersonic programs exist that he cannot speak about. “There are probably six different types of hypersonic programs that we have,” Bussing said in a recent interview. “There are probably six different types of hypersonic programs that we have,” Bussing said in a recent interview. “Some are classified, so I can’t speak [about] them because we are not at liberty to announce them.” But he named Raytheon’s role in four hypersonic programs: TBG, HAWC, CPS and LRHW.

The Defense Department has inserted $10.5 billion into a five-year budget plan released in March to develop and field the long list of offensive and defensive hypersonic weapon systems. But a detailed check of the budgets for unclassified programs reveals a significant surplus, which could be used to fund classified projects.
Boeing is considering the drastic move of temporarily halting 737 MAX production and rejigging 777X assembly plans as uncertainty continues over its two newest commercial aircraft programs.

Executives at the beleaguered aerospace giant acknowledged July 24 that it will accelerate assembly of 777 freighters next year to offset the impact of a slowdown on the new 777X linked to its General Electric GE9X engines. Yet despite facing what could be a year-long delay to flight test and delivery, the widebody program issues barely register when compared to those of the 737.

In an unexpectedly candid revelation during the company’s second-quarter earnings call, the manufacturer acknowledged that its 2020 737 production-line-rate plans range from resuming its ramp-up plan to 57 per month to, if the MAX grounding drags on, stopping the line.

“As our efforts to support the 737 MAX’s safe return to service continue, we will continue to assess our production plans,” Boeing CEO Dennis Muilenburg says. “Should our estimate of the anticipated return to service change, we need to consider possible further rate reductions or other options, including a temporary shutdown of MAX production.”

Boeing’s admission that it may suspend production, made as it released its second-quarter earnings, underscores both the uncertainty and gravity of the MAX situation. The company on July 18 revealed $4.9 billion in second-quarter after-tax charges such as anticipated customer compensation linked to the MAX grounding, leading to a record $2.9 billion quarterly loss. Among the assumptions Boeing used to calculate the charges: Regulators would begin to clear the MAX to return to service early in the fourth quarter, and the current 42-per-month production rate would ramp up to 57 per month—meaning eager customers get their MAXs as soon as possible—in 2020.

Boeing may trim or pause 737 MAX production if the fleet is not cleared to fly before 2020.

While many analysts embraced the news as a rare bit of clarity in a fluid situation, Boeing’s earnings-call comments suggest that the MAX’s notional return-to-service timeline and related ramifications are tenuous estimates.

Boeing’s second-quarter charge and production estimates assume “that the regulatory approval in the U.S. and other jurisdictions begin early in fourth quarter 2019,” Chief Financial Officer Greg Smith says. “While this assumption reflects our best estimate at this time, I just want to reiterate that the actual timing and condition of return to service will be determined by the regulatory authorities and could differ from this assumption.”

The 380-aircraft MAX fleet has been grounded since mid-March, following the second fatal MAX accident in five months. Boeing halted deliveries just after the grounding but has been producing MAXs and will soon have 200 in storage, awaiting delivery after regulators clear the model for revenue service.

Boeing has been working on software and training changes designed to convince regulators that the MAX is ready to fly again. While neither the FAA nor Boeing discussed public return-to-service timelines in the weeks after the grounding, Boeing was set to

Sean Broderick Washington and Guy Norris Los Angeles
present a finalized version of its changes to the FAA in April when several issues cropped up. Boeing did not provide a revised timeline estimate until its recent second-quarter charge revelation. During Boeing’s second-quarter call, Muilenburg reiterated that Boeing’s current assumptions include delivering the final package detailing the changes to the FAA “in the September time frame.”

One current pacesetting issue, identified by the FAA during engineering simulator trials in mid-June, focuses on a flight control computer (FCC) microprocessor. FAA pilots testing FCC failure scenarios found one situation where the agency pilots determined the system did not respond quickly enough, apparently due to a data-processing issue. Boeing is confident that software changes will address the anomaly and is “in the middle of working our way through that,” Muilenburg says.

It is also working with the FAA and other regulators to address questions related to the primary changes, which focus on the MAX’s Maneuvering Characteristics Augmentation System (MCAS) flight-control law. MCAS is at the center of probes into both fatal MAX accidents, Lion Air Flight 610 last October and Ethiopian Airlines Flight 302 this March. Implementing the MCAS-related changes and addressing all other issues uncovered by regulators, such as the microprocessor anomaly, is required for the MAX to earn regulatory approval.

“All of those inputs have been considered in our current timeline analysis and are consistent with the timeline that we laid out here for submitting our certification package in the September time frame and return to service in the October time frame,” Muilenburg says.

If Boeing’s assumptions hold, plans call for the 737 production rate, reduced from 52 per month to 42 per month just after the groundings, to steadily increase in 2020. Some of the 600 MAX suppliers were delivering at a 57-per-month rate just before the MAX groundings to support a long-planned ramp-up scheduled for this year. The rate cut introduced more variation, Muilenburg says, noting that current monthly supplier rates range from 42 to 57 shipsets per month. If the return-to-service (RTS) timeline is extended, Boeing will look at further production-rate cuts.

“It depends on the [RTS] timeline and our understanding of the timeline,” Muilenburg says. “Stepping down to a lower production rate . . . will present some challenges more broadly to our supply chain [and] synchronization of our workforce as well. So in some cases, depending on [the] timeline, a temporary shutdown of [the] production line could be more efficient than a sustained lower production rate. And that’s what we’re thinking our way through.”

While next year’s 737 production plans remain in flux, Boeing has already decided to make changes in its 777 assembly plan to ensure it maintains its current rate even as delays push back the 777X’s debut.

“We continue to expect 777 delivery rates to be approximately 3.5 aircraft per month in 2019,” Muilenburg says. “Given the pressure around [the] 777X first-delivery timeline, we are reassessing the 2020 skyline. In light of the strong demand for our freighter line, we intend to mitigate some of the impact by producing more 777 current-generation freighters in 2020.”

Although the initial 777Xs are assembled on a temporary line in Everett, Washington, Boeing’s plan was to align the phasing out of current-generation passenger models with the 777X ramp-up—eventually merging the new models and current 777F models on the existing main 777 assembly line. It does not offer a 777X freighter and will continue to offer current-generation freighters for the time being. Boeing’s revised plan will bring forward assembly of some freighters to maintain the tempo of the overall production system and sustain the company’s long-run-
A hexapod autonomous electric vehicle would align and lift the detachable fuselage pod to connect with the carrier aircraft.

2018 revenues of €1.5 billion ($1.7 billion), Akka provides outsourced engineering and R&D services to the automotive, aerospace and other industries. It supplies engineers with specific skills to design products or subsystems. The services offered range from mechanical engineering to digital transformation.

Founded in France in 1984, Akka took control of Daimler-Benz's engineering subsidiary MBTech in 2012. Automotive is its largest business sector: Aerospace is its second largest, and in November 2018 Akka acquired U.S. engineering and technologies services provider PDS Tech, with customers that include Boeing, Gulfstream and Mitsubishi Aircraft.

Akka Research undertakes internal R&D projects to train graduates, develop engineers’ skills and acquire technology expertise valuable to customers. Past projects have included a collaborative mobile robot for aircraft inspection, an ultralightweight carbon-fiber airline-seat structure and Omega, a vertical-takeoff-and-landing unmanned aircraft.

Link & Fly takes its inspiration from Akka’s Link & Go autonomous vehicle concept, unveiled in 2011. This project reimagined urban transport as a fully electric car that could drive and park itself while passengers in a lounge-style cabin were continuously connected via social media. Several of the ideas have found their way into customers’ autonomous vehicles, says Akka.

“Grasped that to conceive a mobility solution based on an aircraft, recenitered around the needs and comfort of the passenger and as comprehensive as it can be, including the airport,” says Olivier Caperon, Link & Fly project leader: “The first idea was to isolate the phases of boarding and turnaround.” The resulting modular aircraft comprises a wing-propulsion carrier and detachable fuselage pod.

Detached from the aircraft and transported inside the airport, the cabin is easier for passengers to board. A smaller footprint is required for loading and unloading, making it possible to locate the airport terminal close to the city center and public transport. Meanwhile, decoupling passenger boarding and deboarding from turning the aircraft around reduces its time on ground.

Detachable cabins can be configured in different ways: pressurized for passengers or VIPs or unpressurized for cargo. In Akka’s concept, this would allow airlines to adopt a different business model, leasing the carrier aircraft and only having to purchase the different types of fuselage pod.

“The second main idea is to use the project as an innovation platform where teams can develop new competencies,” says Pierre Guenoun, head of Akka Research France. “We have developed several technology innovations that have been incorporated in the reg-
This is Sikorsky’s S-97 Raider, being put through its paces before a select group of suppliers the company wants on board to support its bid to build the U.S. Army’s next armed scout—the Future Attack Reconnaissance Aircraft (FARA).

Sikorsky is one of five companies chasing two contracts to build prototypes for a competitive flyoff in 2023. If successful, FARA would be the fourth instantiation of Sikorsky’s X2 high-speed helicopter configuration including the original 6,000-lb. technology demonstrator, the 11,500-lb. S-97 Raider and the 33,000-lb. Sikorsky-Boeing SB-1 Defiant demonstrator, also now in testing.

This line of aircraft has its origins in 2005 when, seeking to differentiate itself from other helicopter manufacturers and after analyzing a range of configurations, Sikorsky returned to the design of its XH-59 Advancing Blade Concept (ABC) coaxial compound helicopter demonstrator. First flown in 1973, it achieved 238 kt. in level flight.

To overcome the ABC’s drawbacks of complexity, vibration and high fuel consumption, Sikorsky applied technologies developed in the intervening years, including carbon-fiber blades and airframe, fly-by-wire flight controls, integrated propulsion system and active vibration control. The result was the X2 demonstrator, which in 2010 achieved 250 kt. in level flight with power still in hand.

The next step was to use the configuration “to make something useful,” says Steve Weiner, director of engineering sciences and “father of the X2.” The result was the S-97 light tactical helicopter, designed around the Army’s Armed Aerial Scout (AAS) requirements. Sikorsky and its supplier partners launched an industry-funded program to build two prototypes, the first of which flew in May 2015.

AAS was canceled in 2013, with the Army blaming budget sequestration. It then retired the Bell OH-58D Kiowa Warrior armed scout that AAS was to replace, and its role was transferred to the Boeing AH-64E Apache. But the Army acknowledges the attack helicopter is not best suited to armed reconnaissance, and in 2018 FARA emerged as an urgent requirement to field 200 new armed scouts beginning in 2028.

On paper, Sikorsky looks well placed to win FARA. The company, parent Lockheed Martin and its industry partners have invested about $300 million in the Raider, says Chris Van Buiten, vice president of Sikorsky Innovations. The second prototype has exceeded 200 kt. in flight testing, and FARA would be an evolution of the S-97 configuration, rather than an entirely new design.

But Sikorsky faces a challenge. To enable a competition, the Army has trimmed its requirements for FARA, setting a minimum speed of 180 kt.—fast for a conventional helicopter, but slow for the X2. That speed requirement pits Sikorsky’s coaxial-rotor compound design against single-main-rotor helicopters and brings the affordability
of its more capable, but more complex configuration into sharp focus.

Tim Malia, Sikorsky's director of future vertical lift-light, describes the company's driving priorities for FARA as a triangle, with schedule, performance and affordability as the three sides. The Army has made clear that "schedule is king," he says, but to win, the company must also get the other two right.

Sikorsky should be in a good position on schedule. The Raider has already logged more than 55 hr. of flight testing, reaching 207 kt. in level flight and pulling 2g in maneuvers. The first prototype was damaged in a hard landing in August 2017, but the second aircraft has been transferred to the FARA team, and flight testing refocused on reducing the risk in Sikorsky's proposal.

The Raider was showcased to industry partners and the press on June 25, with a demonstration at Sikorsky's development flight center in West Palm Beach. This highlighted the compound-helicopter's unique capabilities enabled by its combination of rigid coaxial rotors and tail-mounted propulsor.

There are two 94-ft.-dia., contra-rotating four-blade rotors. The blades are stiff and the hubs hingeless so the rotors can be mounted close together, reducing drag. This configuration enables higher airspeed because lift is generated by the advancing blades on each side, allowing the pitch of the retreating blades to be reduced and avoiding the blade stall that limits the speed of conventional helicopters.

Rotor speed is scheduled with tip Mach number and reduces to a minimum of 85% rpm as airspeed increases to prevent the advancing blades going supersonic. The distance between the tips of the upper and lower rotors is actively sensed. Two-thirds of the tip gap is to allow for blade flexing during maneuvers, and one-third is the safety margin, says Bill Fell, senior experimental test pilot.

In the August 2017 accident, a flight-control software error led to a roll rate on liftoff three times greater than intended. Gyroscopic forces caused the rotor tips to collide. "We fixed the error in the code, and we now completely understand the physics," he says. "Our job is to make sure it never happens again."

The Raider is powered by a single 2,600-shp General Electric YT706 turboshaft. In hover and at low speed, power goes to the rotors and the propulsor is declutched. As speed increases and the propulsor is engaged, power shifts to the six-blade, variable-pitch pusher propeller. At high speed, 90% of the power goes to the propulsor, says Fell.

Pilots increase or decrease propulsor thrust using a "beep" switch on the central collective lever. This moves propeller pitch through its range of +50 to -20 deg. The rotors can take up to 1,800 shp of power, the propeller 2,200 shp. The engine cannot provide full power to both simultaneously, so the integrated digital engine and flight controls automatically maintain the rotor power required for lift and limit the propulsor to the excess power available.

The Raider can fly at up to 150 kt. with the propeller disengaged. This allows the helicopter to dash at high speed then declutch the propulsor to reduce the noise on approach to the target. There is no anti-torque tail rotor. As the prototype demonstrated, there is a significant reduction in acoustic detectability when the propeller is disengaged.

The propulsor offers other unique capabilities. Conventional helicopters tilt nose-down to accelerate and nose-up to decelerate. Using forward or reverse thrust on the propulsor allows the Raider to slow down or speed up with a level fuselage attitude. This is valuable when carrying casualties or passengers, says Van Buiten. Tactically, using the propeller can prevent the aircraft from being spotted by enemy defenses.

By using reverse thrust on the propeller counteracted by forward thrust on the rotors, the S-97's fuselage can be pointed downward. Fell showed how this allows sensors or weapons to dwell on the target as the Raider circles, nose down. Forward thrust on the propeller balanced by rearward thrust on the rotors, allows the fuselage to be pointed upward. These are capabilities conventional single-rotor helicopters do not have, but the value of which must still be demonstrated to the customer.

Although speed is no longer the focus of testing, Sikorsky still hopes to achieve the Raider's 220-kt. design goal. "We underestimated the drag," says Fell. "But there are dials we can tweak." Sikorsky is preparing to install a new set of rotor blades, redesigned to reduce drag and vibration at high speed—another area of concern with the rigid-rotor helicopter. In addition to being stiff, the Raider's blades are complex, with changing thickness and chord across five different airfoil sections from root to tip.

Fell says vibration in the Raider at more than 200 kt. is similar to that in the UH-60 Black Hawk at 150 kt. But the potential impact of vibration on crew fatigue, aircraft systems and component lives is a concern, although the S-97 is equipped with an active vibration control (AVC) system. The new blades have been redesigned to improve aerodynamic efficiency, but how they attach to the hingeless hubs also has been modified, says Fell, to reduce the transmission of vibratory forces from the blades into the airframe.

The importance of minimizing vibration was illustrated during the demonstration flight. Fell says the flight plan called for a 200-kt., high-speed pass, but maximum speed was held to 190 kt.

"We planned 200 kt., but a new script file in the AVC did not work out, and there was no reason to push it," he says. AVC actively cancels vibration by introducing opposing forces into the airframe.

Mitigating vibration is one example of risk-reduction testing the Raider will perform for the FARA team, which is
nearing its preliminary design review. Because the Army has reduced its speed requirement, Sikorsky’s FARA design will be “detuned” relative to the Raider, but will still have more growth potential than a single-rotor helicopter already at the limits of its capability at 180 kt., says Malia.

With a larger, 39-ft.-dia. rotor system, a higher, 14,000-lb. gross weight and a single, 3,000-shp General Electric T901 Improved Turbine Engine, the FARA will be slower than the Raider, he says. There will be other changes. The fuselage will be stretched to accommodate two 80-in.-long internal bays for weapons, air-launched unmanned aircraft and other mission payloads. There will be no external stores on FARA, Malia says, and these bays will essentially replace the Raider’s passenger cabin.

The fuselage will be tuned to minimize vibration, he says. Sikorsky has already selected Swift Engineering to build the airframe for the FARA prototype. Aurora Flight Sciences built the Raider fuselage but is now owned by Boeing, and Swift manufactured the airframe for the SB-1 Defiant. Suppliers of other long-lead components are also already on board, Malia says, to meet a schedule that calls for contract award in March 2020, flight in first-quarter fiscal 2023 and the Army flyoff in the fourth quarter of that year.

The landing-gear arrangement is different on the FARA design, and there are changes to the propulsor. On the Raider, when the propeller is disengaged a limited-slip clutch keeps it turning at 200 rpm. This is to avoid heat damage to a blade from the engine exhaust, which is located above the tail, just forward of the prop. On FARA, as on the Defiant, the exhaust design is different, and the propulsor will stop completely. Sikorsky could also redesign the propeller blades to reduce noise in high-speed flight.

For Sikorsky, tailoring its X2 configuration to the less-demanding FARA requirements is crucial to making it affordable. But the company wants to preserve the design’s inherent growth capability—particularly for speed—because it sees this as a differentiator. After decades of false starts, the Army urgently needs an armed scout. A conventional helicopter could do the job, but Sikorsky needs the service to take the long-term view and pick a configuration still at the beginning of its evolution.

Combat Rescue Helicopter
Back on Track

Graham Warwick West Palm Beach, Florida

Six months after being criticized for design issues and schedule delays, Sikorsky says its HH-60W Combat Rescue Helicopter (CRH) program is back on track to support a production decision in September and deliver much-needed replacements for the U.S. Air Force’s aging HH-60G Pave Hawks.

First flight of the HH-60W slipped to March from October 2018, but testing has already passed 30 hr. as the company drives to achieve the 50-hr. mark required to support an on-schedule Milestone C production decision by the end of September.

An independent assessment of the program in December projected that development of the HH-60W would take 81 months, instead of the 75 months planned when the $1.2 billion contract was signed in 2014. “We are back on the contract schedule,” says Greg Hames, Sikorsky’s CRH program director.

The first of four engineering development model HH-60Ws, EDM1, first flew on May 17. EDM2 followed on May 23. EDM3 is in fuel-system calibration testing, with EDM4 ready to follow. Both are scheduled to fly in August, says Hames. The CRH test aircraft are based at Sikorsky’s development flight center in West Palm Beach, Florida.

“We are back on the 75-month baseline contract schedule that we need to support Milestone C and RAA [Required Assets Available],” he says. Scheduled for September 2020, RAA requires Sikorsky to have delivered the four EDMs, one Aircraft Systems Test article for maintenance testing, five System Demonstration Test Articles for operational testing, plus training devices and courseware.

Schedule recovery has been enabled by “right-to-left” planning, which identified the critical milestones that must be met to achieve Milestone C and RAA, says Hames. EDM1 and 2 are completing initial shakedown testing of the engines, dynamic system, avionics and handling qualities in the full CRH configuration including window-mounted weapons. After the July 4 holiday, both aircraft will begin data-collection flights to support Milestone C. These will comprise about 14 hr. of flight-load surveys and 22 hr. of performance testing, says Hames.

EDM1 and 2 are fully instrumented. EDM3 and 4—the electrical and avionics test aircraft, respectively—have less instrumentation but will support the data-collection campaign once they join the test program, he says.

Milestone C approval would trigger awards totaling $564 million for the first two low-rate initial production lots of 10 and 12 aircraft, respectively. The Air Force plans to procure 113 HH-60Ws to replace its HH-60G Pave Hawk combat rescue helicopters.

Now well beyond their 6,000-hr.
A conventional helicopter could do the job, but the Army urgently needs an armed scout helicopter that is more maneuverable and capable—particularly for speed—than the HH-60W, because it sees this as a differentiator. However, affordability is crucial to making it a reality.

The company knows it needs to meet a schedule that calls for completing the first flight with the CRH to be no external stores on FARA, and that there are changes to the propulsor. Sikorsky could also redeploy the exhaust, which is located above the tail, to protect the propulsor. The exhaust is also disengaged a limited-slip clutch keeps the tail from cocking and the propulsor will stop during a walk-around of the EMD3.

EDM1 and 2 are flying in full CRH configuration to ensure drag and performance data are accurate.

Hames pointed out the changes during a walk-around of the EMD3 and 4 at the Sikorsky test center on June 23. Notable externally are the extendable inflight-refueling probe, nose-mounted radar and reshaped nose for increased avionics cooling. Mounted above the starboard cabin door, the Breeze-Eastern rescue hoist is now electric instead of hydraulic.

Of note internally are the large self-sealing fuel tank installed aft of the cabin and new crashworthy crew seats developed by East/West Industries. Mounted behind the pilot seats, these allow the rear crew to face forward in flight then swivel outward to operate the window-mounted guns. In the HH-60G, the crew seats are fixed facing sideways. When facing forward, screens mounted on the backs of the pilot seats repeat the cockpit multi-function displays and provide the rear crew with situational awareness.
As the September decision-time on proceeding with production of the Sikorsky HH-60W approaches, U.S. Air Force scientists and industry engineers are exploring a radical new approach to the combat search-and-rescue (CSAR) mission.

At the core of the new effort are concerns that conventional rotorcraft have become too vulnerable for rescuing downed aircrews deep within contested airspace. A four-year-old report by the Rand Corp. think tank also highlighted the statistical significance of time in a rescue operation, with the odds of success falling dramatically after about 15 min.

So the Air Force Research Laboratory (AFRL) and private companies are trying to fill the gap in the CSAR force structure. The goal is not to replace conventional rotorcraft, but instead invent new ways to move survivors to safer locations for an HH-60W to extract them.

In the last two months, two different solutions have emerged. One calls for air-dropping an autonomous, electric-powered personal air vehicle (PAV) to whisk survivors to a safer extraction point. The other concept calls for using another aircraft in the strike package to hoist survivors using a podded extraction system.

The first concept became public on May 2. The AFRL solicited small businesses to apply for a special grant to develop a “personnel recovery/transport vehicle.” The concept appears based on a flying version of a recovery method used by Air Force Special Operations Command (AFSOC), which involves air-dropping an all-terrain vehicle to an uninjured survivor.

Instead of using a ground vehicle, the AFRL hopes to leverage new advances in autonomy and electric-powered aircraft in development to support the nascent urban-air-mobility market. After being released from a transport aircraft such as a C-130, a guided parachute would deliver the PAV to the survivor’s location with at least one rescuer. The survivor and rescuer then would escape by boarding the PAV, which is expected to transport them at least 100 nm away.

The AFRL declined to elaborate on the concept because the small-business innovation research grant for it remains under source-selection. The deadline to apply for the grant was July 1. The other concept was announced June 5 by Modern Technology Solutions Inc. (MTSI), an engineering firm that primarily serves the military market.

MTSI’s Rapid Aerial Extraction System (RAES) offers a new and potentially safer approach to a Vietnam-era concept called the Fulton Recovery System. The Fulton method uses an AFSOC MC-130E equipped with a nose-mounted fork and winch in the cargo bay. As the MC-130E flies over the survivor, the crew lands a container by parachute. Inside the container is a balloon attached to a 500-ft. steel cable. After the survivor inflates the balloon and is strapped onto the cable, the MC-130E flies a second pass at about 400 ft., snares the cable and jerks the survivor in tow. Once in the air, the MC-130 crew hooks the cable to the onboard winch and hoists the survivor into the cargo bay. Some successful recoveries have been recorded, but there are also severe risks.

MTSI’s approach instead is modeled on a special technique developed in the 1950s by Nate Saint, a Christian missionary in South America. To deliver gifts and items to remote tribes, Saint’s small aircraft released a container on a rope. As the container fell, Saint turned the aircraft in a circle, causing the rope to shape into a spiral. At the vertex of the spiral, the container was stationary. By releasing more rope while continuing to orbit, the container would descend in a straight line until it reached the ground softly.

If use of that technique could deliver a package, it also could extract one. Using internal funds, MTSI staged a demonstration last February. A light aircraft retrieved a package on the ground. Instead of using a violent jerk caused by the Fulton slanted-recovery approach, Saint’s technique is far more gentle. As the aircraft flies out of the orbit, the survivor is pulled vertically as the slack in the spiral line straightens. In the February experiment, the vertical force on the package measured less than 2g, according to MTSI.

In the MTSI approach, the rescue is made by another aircraft in the strike package equipped with the extraction pod. The pod includes a container with a parachute and a quick-release mechanism for the survivor. Once over safer territory, the survivor releases from the aircraft cable and parachutes to the ground to await extraction by conventional helicopters.
Australia Wants Tiger Successor Operational by 2026

> CANDIDATES ARE THE AH-1Z, AH-64E AND MODERNIZED TIGER
> FORCE TO INCREASE TO 29 FROM 22

Bradley Perrett Beijing and Tony Osborne London

Exasperated by the unreliability of its 22 Airbus Tiger ARH attack helicopters, Australia said in 2016 it would replace them by the mid-2020s, barely a decade after the fleet became fully operational. Two years later, that plan looked doubtful: The Tigers’ performance had improved markedly, so industry managers began to think Canberra would have higher priorities.

That has not been the case. The country's defense department has issued a request for information on 29 replacement helicopters and set out a specific timetable for their introduction. The increased number and a proposal for a training detachment show that the Australian Army's thinking has moved beyond mere replacement—it wants a step-up in capability.

The request for information requires “a proven and mature, manned off-the-shelf” type of armed helicopter and reflects Australia’s experience as an unwilling early operator of the Tiger. Bell and Boeing say they will respond with the AH-1Z Viper and AH-64E Apache, respectively. Airbus proposes modernized Tigers, evidently to the Mk. 3 standard, although this update has not progressed beyond studies. Its status raises the question of whether it will qualify as a proven design.

The replacements should be initially operational by 2026. A squadron will be equipped with 12 helicopters and able to sustain a deployment of four, according to the defense department’s unclassified request for information, reviewed by Aviation Week. Final operational capability should be achieved by 2028, with 24 helicopters in a regiment of two squadrons at one location and five in a training unit that could be based elsewhere.

The 22 Tiger ARHs are the army’s first attack helicopters—though their mission is called armed reconnaissance. The replacements are required to provide “armed reconnaissance effects in the close and deep contested battlespace,” the department said.

The program is called Land 4503. The request for information was issued on July 1, with responses due by Aug. 30.

Boeing and Bell have been promoting their attack helicopters to Australia. The Viper has an advantage in this case due to its design for shipborne operation, since the department says the chosen type will need to sustain prolonged operations from the Royal Australian Navy's Canberra-class assault ships.

Although they are army helicopters, the Tiger and Apache have been deployed at sea. But Bell says the Viper is the world’s only marinated attack helicopter, since it has features needed for sustained shipborne operation: blade folding for quick stowage, brakes for stopping rotors quickly, a design for easy maintenance in tight spaces and electromagnetic hardening against nearby naval radars.

Airbus says it is fully committed to keeping the Tiger in Australian service well beyond 2025, the end of the latest support contract. “We are confident that we can offer a cost-effective modernization of the platform to take it through to the 2040s.” In Australia, “costs of [the] Tiger have reduced by more than 90%, and the mission sortie success rate is currently sitting at above 95%,” the company says, adding that the government acknowledges these measures as unmatched.

Two members of the Australian Army who are closely involved in Tiger operations confirm that the type is now reliable, in contrast to difficulties during initial operations. When Australia ordered Tigers in 2001, it had expected lead operators France and Germany to sort out early problems. But when Australian deliveries began in 2004 the type was far from mature, so the army found that it was one of the initial operators.

“Fifteen years on, we are achieving good availability, a good rate of effort; we are a fleet leader on a platform, but we were not planning to be that fleet leader,” the defense department’s Brig. Gen. Jeremy King told IQPC’s Interna-

An Airbus Tiger ARH aboard the assault ship HMAS Canberra.
Russian Ilyushin Il-76 and Antonov An-124s carrying the first elements of an Almaz-Antey S-400 air defense system that has shaken up the NATO alliance arrived in Turkey at Murted Air Base on July 12. Four days later, President Donald Trump said the U.S. is telling Turkey, “We’re not going to sell you the F-35.”

The long-expected delivery of the $2.5 billion arms package now sets in motion a process that could lead to the expulsion of the third-largest customer in the Lockheed Martin F-35 program, slap Congressional-mandated sanctions on Turkish arms buyers and manufacturers and expose a new fissure in the NATO alliance.

“Parts of the system will continue to be delivered in the coming days, after the system is fully ready to be used as determined by the relevant authorities,” the SSB (Turkey’s Undersecretariat for Defense Industries) said in a statement on its website.

Despite the high stakes, the bureaucratic machinery in Washington moved slowly to respond to the move. Mark Esper, then nominee for U.S. defense secretary, issued a terse statement on July 12, saying only that his department’s stated position that Turkey faces expulsion from the F-35 program has not changed. But the Pentagon set up, and then canceled, two press conferences on the topic on July 12 and 15.

The latter date may partly explain the Pentagon’s awkward response and perhaps even the timing of Russia’s delivery. July 15 marks the three-year anniversary of a failed coup by the Turkish Air Force against President Recep Tayyip Erdogan, an event that some experts believed triggered Turkey’s interest in Almaz-Antey’s S-400 technology.

During his Senate confirmation hearing July 16, Esper expressed regret about Turkey’s “disappointing” decision to move forward with the S-400 delivery. “You can either have the S-400 or you can have the F-35. You cannot have both. Acquisition of the S-400 fundamentally undermines the capabilities of the F-35,” he said.

Before a Cabinet meeting the same day, the U.S. president addressed the issue. “It’s a very tough situation that they’re in. And it’s a very tough situation that we’ve been placed in the United States,” Trump said, according to a White House pool report. “With all of that being said, we’re working through it. We’ll see what happens, but it’s not really fair.”

He added, “We are now telling Turkey . . . we’re not going to sell you the F-35 fighter jets.”

The situation sets up an almost impossible diplomatic problem for both sides. The Pentagon has already begun to unwind Turkey’s participation in the F-35 program, and the Countering America’s Adversaries Through Sanctions Act (Caatsa) gives Trump little room to maneuver unless Turkey capitulates. For their part, Turkish government and military officials have refused to meet U.S. demands, which now would require returning or destroying the S-400 equipment after it has been delivered.

“It’s just a train wreck,” says Jim Townsend, the former deputy assistant secretary of defense for Europe and NATO and now an adjunct senior fellow at the Center for New American Security. “I don’t see how they’re going to have F-35s on one end and S-400s on the other,” he says. “So someone is going to lose.”

The U.S. government’s objections to an operational S-400 system in Turkey are based on technical and strategic risks. U.S. officials say Turkey’s F-35s are incompatible with the S-400 as part of the same integrated air defense system. The acquisition also draws Russia closer to a NATO alliance member in a strategic location that controls access to the Black Sea and stands adjacent to several violent flash points in the Middle East.

It is a combination that threatens a
rupture in the U.S.-Turkish relationship, despite a deep entwining of military hardware and industrial supply chains. By the end of July, the U.S. plans to expel Turkish participants in the F-35’s pilot and maintenance schools and program office. By the end of 2020, the Joint Program Office plans to start replacing Turkish suppliers in the F-35 supply chain mainly with U.S. alternatives.

The consequences for Turkish industry could be even more severe. In 2017, Congress passed Caatsa to punish Russia’s arms export agency in response to the annexation of Crimea, but the terms require the Trump administration to apply the law on countries that buy from Rosoboronexport.

The question now is “how hard they will go?” on Caatsa sanctions against Turkey, says Thomas Karako, a senior fellow at the Center for Strategic and International Studies.

The path to the arrival of the S-400 on Turkish soil has been long, circuitous and sometimes contradictory. As the acquisition unfolded over the past decade, Turkey’s sense of vulnerability to air and missile attack would evolve into an obsession. Potential deals with China and the U.S. fell apart over Turkey’s refusal to back down on requirements for technology transfer and local production, yet Russia’s selected offer contained neither.

The acquisition began a decade ago with the launch of a formal tender called the Long-Range Air and Missile Defense System (T-Loramids). As Turkish companies worked to become proficient with short- and medium-range anti-aircraft missiles, T-Loramids was envisioned as an off-the-shelf solution that could fill a perceived gap in Turkey’s air defenses and deliver the know-how to make Turkish companies ultimately self-sufficient in the future.

As the tender process unfolded, Turkey’s regional security outlook worsened with the rise of the Arab Spring in 2011. A Turkish RF-4E was shot down over the Mediterranean Sea by Syrian surface-to-air missiles in 2012, which only underscored Ankara’s sense of vulnerability. NATO finally agreed to deploy U.S. and German Patriot batteries along Turkey’s southern border in 2013, as the tender process for T-Loramids continued.

Finally, the SSB’s selected bidder for T-Loramids in 2013 stunned NATO and Washington. Turkey selected the Chinese FD-2000, a derivative of the S-300 produced by a sanctioned company, over bids based on the U.S. Patriot, French and Italian Eurosam SAMP/T and Russian S-300V.

Although the FD-2000’s selection would raise compatibility and security issues that would be repeated five years later, that is not why the deal ultimately fell apart. Negotiations between Turkey and China to finalize the contract dragged on for three years, even as tensions continued to rise along Turkey’s southern border, reaching a crescendo with the shooting down of a Russian combat aircraft in November 2015.

NATO had withdrawn U.S. and German Patriot batteries a month earlier in 2015 and replaced them with a Spanish Patriot deployment to Adana and an Italian SAMP/T battery located in Kahramanmaras. In negotiations with the Chinese, however, the sticking point was over the details of technology transfer, which ultimately China was unable to provide to Turkey’s satisfaction.

As the U.S. balked at Turkey’s demands in 2016 for local assembly of Patriots, Turkey’s leadership was shaken by an internal security threat. Shortly after Erdogan survived the attempted coup by the air force in 2016, the Russian government offered to sell Turkey four S-400 batteries and signed a deal in December 2016.

Yet Turkey continues to show interest in the SAMP/T system, even agreeing to study the joint development of a derivative built to Turkish specifications with France and Italy just days after the S-400 signing, although little progress has been made. Meanwhile, the Trump administration has approved Turkey to receive the Patriot missile system. As the S-400s arrived on July 12, local media quoted Turkish officials as saying that a Patriot deal was still possible, but not at the expense of the S-400 order.

If the saga continues along the same track, more twists and surprises may await both sides before the matter is settled for the F-35, the S-400 and Turkey’s position in NATO. For now, observers can only scratch their heads and wonder how the dispute will be resolved.

“It’s probably going to be tough for Erdogan to walk away from this,” Karako says. 😞

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**The Economic Impact of Turkey’s F-35 Exit**

Extricating Turkey from the F-35 program will cost an estimated $9 billion for 10 Turkish suppliers over the life of the fifth-generation fighter. Turkey has made more than 900 parts and assigned $1 billion in industrial partnership across its supplier base, says Ellen Lord, U.S. undersecretary of defense for acquisition and sustainment. The shift will cost the U.S. $500-600 million. “To bridge the gap initially to mitigate Turkey’s removal, the program will use primarily U.S. sources for Turkey’s workshare, but this will gradually open up to program partners for first, second and third sources,” Lord says.

A Lockheed Martin executive says the U.S. government will compensate F-35 suppliers for any financial costs caused by Turkey’s expulsion from the program. Lockheed is still on track to deliver 131 F-35s this year and replace Turkish suppliers within eight months without disruption, says Lockheed CEO Marilyn Hewson.

It is undecided what will happen with the aircraft Turkey purchased that are residing at Luke AFB in Arizona.

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**Key Turkish F-35 Suppliers**

- **Alp Aviation** produces airframe structures and more than 100 F135 production engine parts.
- **Fokker Elmo** planned to make 40% of F-35 electrical wiring and interconnection systems. Delivering center section wiring systems.
- **Havelsan** provides training systems support.
- **Kale Aerospace** was manufacturing airframe structures and was the sole supplier for landing gear uplock assemblies. Planned to make production hardware for the F135 under a joint venture with Pratt & Whitney.
- **Roketsan** and Tubitak-SAGE were developing and integrating the stand-off missile to be carried internally on the F-35. Teamed with Lockheed Martin to develop and produce the weapon.
- **Turkish Aerospace Industries** was on contract to supply 100 center fuselages for Northrop Grumman. Planned to produce composite skins, weapon bay doors, composite air inlet ducts and air-to-ground pylons and adapters.
Sometimes little things can make a big difference. Issues with components to upgrade the Ground-based Midcourse Defense (GMD) System envisioned to protect the U.S. from Iranian and North Korean ballistic missile threats are delaying work on a subsystem and may slow the production of new and retrofitted interceptors.

The Redesigned Kill Vehicle (RKV) will replace the aging Exoatmospheric Kill Vehicle (EKV) for 64 ground-based interceptors (GBI), but concerns about suspect components on the RKV have prompted the Pentagon to stop work on the program. The EKV is designed to destroy targets in high-speed collisions after separating from a booster rocket outside the atmosphere. The system has in the past had its struggles in testing, but the EKV’s Capability Enhancement II variant performed reliably in a complex salvo test in March, indicating that the GMD system could protect the U.S. against multiple threats from incoming ICBMs.

Forty-four GBIs reside at Fort Greely, Alaska, and Vandenberg AFB, California. The U.S. intends to add 22 missile silos at Fort Greely to support 20 more GBIs. The RKV was slated to complete a critical design review in 2018, but instead the Missile Defense Agency’s (MDA) fiscal 2020 budget request revealed the milestone was delayed by two years. That backs up the remaining procurement of 20 additional GBIs to fiscal 2021, MDA fiscal 2020 budget justification documents reveal.

The Pentagon encountered a technical issue in the RKV-development program, and the team has been assessing and testing suspect components as needed. “After receiving recent test results, the undersecretary of defense for research and engineering [USD (R&E)] determined that the current plan is not viable and has initiated alternative courses of action,” Pentagon spokeswoman Heather Babb tells Aviation Week. “To avoid unnecessary expenditures, USD (R&E) has directed the Missile Defense Agency to issue a stop-work on the RKV activity within the current Boeing contract until a viable path forward is identified.”

Boeing confirms to Aviation Week the company was directed to stop work May 24 on the RKV and is assisting the government by responding to requests for information. “We stand ready to support the MDA on alternate pathways to provide the additional GMD capability and capacity mandated by the 2017 [National Defense Authorization Act],” company spokesman Jerry Drelling tells Aviation Week.

The MDA explains that it is necessary to take a step back and reassess the design of the whole program. “We came through a preliminary design review as we approached the critical design review at the end of last year,” MDA Director Vice Adm. Jon Hill told reporters during a Pentagon briefing. At the time of the briefing, he was a two-star flag officer, serving as the organization’s deputy director.

The Pentagon does not want to repeat its EKV development mistakes. “We could do what some programs do and what the [MDA] did years ago, which was to go ahead and produce what we’ve got, and then deal with reliability issues and engineering [USD (R&E)] determined that the current plan is not viable and has initiated alternative courses of action,” Pentagon spokeswoman Heather Babb tells Aviation Week. “To avoid unnecessary expenditures, USD (R&E) has directed the Missile Defense Agency to issue a stop-work on the RKV activity within the current Boeing contract until a viable path forward is identified.”

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within the fleet—and then erode the confidence of the warfighter. We know that is the wrong step," said Hill.

The Government Accountability Office (GAO) says the RKV development program accepted too much risk, and it estimates the two-year delay will cost taxpayers $600 million. The MDA accelerated the effort by concurrently performing development and production and reducing the number of flight tests, with the hope of rapidly fielding RKV-equipped interceptors.

“The most significant development issue that emerged in 2018 pertained to RKV’s performance and its planned use of commercial off-the-shelf hardware and reuse of Aegis SM-3 Block IIA components,” states a GAO report released in June. “Our prior work has shown that stabilizing system design before making major production commitments, and relying on knowledge rather than deadlines to make acquisition decisions at key milestones are best practices of successful product developers.”

Congress is supportive of getting a reliable RKV but remains concerned about the efficacy of the Pentagon’s GMD strategy. For example, the Senate is anxious about the GMD system’s ability to continue to pace growing ballistic missile threats to the U.S. without the additional 20 GBIs, according to the Senate Armed Services Committee’s markup of the fiscal 2020 defense authorization bill. The issue will be hashed out in conference with the committee’s House counterpart.

“Accordingly, committee directs the Missile Defense Agency to provide a briefing to the congressional defense committees on options to improve the reliability, performance, and overall effectiveness of the GMD system,” the Senate document reads. “The briefing shall include an assessment of the cost, expected reliability benefits, feasibility and advisability of upgrading configuration 1 boosters to configuration 2 and accelerating planned upgrades of the fielded ground-system components ahead of projected GMD Development and Sustainment Contract dates.”

The White House is skeptical of cutting $150 million from the MDAs fiscal 2020 budget request for the improved homeland defense interceptor program. “The reduction would be premature pending the result of [the Defense Department’s] analysis of alternative courses of action for the Redesigned Kill Vehicle effort and could cause even further delays to the delivery of 20 additional Ground-Based Interceptors,” says a statement of administration policy sent to House Armed Services Committee leadership.

The House Armed Service Committee is using the RKV developmental hiccup for the U.S. comptroller general to assess the GMD contract structure, but the move will have to be debated with the Senate in conference to move forward. The contract was definitized with Boeing in January 2018, and the military oversight committee noticed significant changes in scope and total value from the initial not-to-exceed agreement, according to the House’s markup of the fiscal 2020 defense authorization bill.

Boeing’s contract modification was awarded with a total not-to-exceed maximum value of $6.5 billion and a period of performance extension to 2023. In March, the MDA definitized $4.1 billion of the contract to build the new missile field but deferred production of 20 additional interceptors. This contract modification brings the total value of the GMD development and sustainment contract, including options, to $10.8 billion.

“The [U.S. comptroller general’s] assessment should also include managing interfaces and specifications between the multiple system components; assessing which elements of missions, if any, could benefit from direct report to the Missile Defense Agency versus the prime contractor; and highlighting any areas that could be improved with regard to the path forward on the Redesigned Kill Vehicle effort and its integration into the overall GMD system,” the House markup reads.

The MDA anticipates the first intercept flight test will occur in fiscal 2023, a second intercept flight test in fiscal 2024, and ultimately placing 20 additional GBIs tipped with the RKV in fiscal 2025.
Turnover in the top ranks of the Defense Department became so bad that members of Congress were demanding an explanation.

The disarray began when Jim Mattis resigned as defense secretary last December, after President Donald Trump announced his plan to withdraw troops from Syria as the U.S. battled the Islamic State group. In June, Mattis’ fill-in, former Acting Defense Secretary Pat Shanahan, whose nomination was never formally submitted to the Senate, abruptly quit after allegations of a domestic dispute surfaced. Following Shanahan’s resignation, Trump swiftly announced his intent to nominate Army Secretary Mark Esper to lead the Pentagon. Esper served in the acting defense chief role until July 15, when his formal nomination paperwork was sent to the Senate. The chamber confirmed his nomination July 23, with a vote of 90-8.

Stipulations in the Federal Vacancies Reform Act do not allow an official to serve in an acting capacity while being considered for the permanent role. Therefore, Navy Secretary Richard Spencer was serving as acting defense secretary in the interim until Congress confirmed Esper to helm the world’s largest military institution.

“As I’ve said before, for the sake of our national security, we need a confirmed secretary of defense—not just an acting—and I hope we can get to that point as quickly as possible,” Senate Armed Services Committee Chairman Jim Inhofe (R-Okla.) said in the runup to Esper’s confirmation. The panel’s top Democrat, Sen. Jack Reed (R.I.), says the vacancy trend has created “disarray” in the government’s largest bureaucracy.

“In the runup to Esper’s confirmation, The panel’s top Democrat, Sen. Jack Reed (R.I.), says the vacancy trend has created “disarray” in the government’s largest bureaucracy. Only twice in the institution’s history has the Pentagon had an acting secretary. The longest and most recent tenure was for two months in 1989 during the George H.W. Bush administration. No administration has had two acting secretaries, but Trump’s topples that record with three.

The Pentagon “is a place with a strong compass or a deep keel,” former Defense Secretary Ash Carter says. “No organization . . . can move forward without a leader.”

It is important to note the Pentagon still runs without a confirmed defense secretary because of career civil servants and uniformed personnel, says Tom Spoehr, director of the Center for National Defense at the Heritage Foundation.

“What you lack without firm, permanent political leadership is this sense that the person who gives you the direction today will be there tomorrow and the next day. It really is serious business that the guidance is not going to change from day to day,” Spoehr, a retired U.S. Army lieutenant general, tells Aviation Week. “That’s really important because people want to believe what they’re doing is meaningful, and if there is some uncertainty, [or] if the guidance has been changed, it inspires a lack of confidence.”

The themes continue to stay the same from leader to leader, but the personalities are different. Continuity is not only important for Pentagon personnel but also for allies and lawmakers, Spoehr says.

However, vacancies are not just a problem at the top of the Pentagon’s civilian ranks. The No. 2 and No. 3 civilian posts at the Pentagon are also occupied by fill-ins. When Shanahan became acting defense secretary in December, Pentagon Comptroller David Norquist stepped up to serve as his deputy. The third most powerful civilian role at the Pentagon—the chief management officer—resigned in November. Lisa Hershman, the former deputy, has performed the duties of the office in the interim.

Esper’s promotion now leaves the Army without a top civilian. And it has been more than two months since the Air Force had a secretary confirmed. Matt Donovan, the former Air Force undersecretary, is serving as acting Air Force secretary after the departure of Heather Wilson in May. John Roth is filling in for Donovan as undersecretary. During her time as Air Force secretary, Wilson clashed with the Trump administration on creating a sixth armed service focus—
ing on space. Instead, she advocated for the space mission to remain within her service, but later provided public support for a Space Force residing within the Air Force—similar to the Marine Corps model.

In the months since her departure, even the space plan supported by the administration has run into staffing difficulties. Space Development Agency (SDA) Director Fred Kennedy resigned in that role and has returned to DARPA until his term of service expires in September. The Pentagon says his exit will not alter plans to establish the SDA.

“[The] SDA will drive the department’s future threat-driven space architecture and will accelerate the development and fielding of the new military space capabilities necessary to ensure our technological and military advantage in space for national defense,” Pentagon spokeswoman Heather Babb tells Aviation Week.

The Defense Department’s fiscal 2020 budget asked to establish the SDA to construct a proliferated, low-Earth-orbit constellation of satellites to provide the military with communications, position, navigation and timing, additional intelligence, surveillance and reconnaissance, and sensor support for missile defense.

Kennedy’s departure comes at a time when Congress is mulling how military space should be reorganized. The House’s version of the defense authorization bill directs coordination between the SDA and the Air Force. But the Senate’s version would expand the role of the principal assistant secretary of the Air Force for space. In this scenario, the head of the SDA, the Space Rapid Capabilities Office and the Space and Missile Systems Center would report to the Air Force secretary.

Not only is Kennedy out as the head of the SDA, but Chris Shank left the Strategic Capabilities Office, and John Stopher, principal assistant secretary to the Air Force secretary for space, has resigned.

Kennedy envisioned leveraging innovative commercial space companies while moving away from high-cost programs the Pentagon has relied on in the past. An example is DARPA’s Blackjack program, which seeks to camouflage military satellites in large, low-Earth-orbit satellite constellations. Informed sources suggest the Pentagon is pulling back its support for collaborating with new entrants in the commercial space industry and instead will rely on traditional prime contractors.

The leadership malaise is also seeping into the uniformed ranks. “We’ll look forward to a confirmed secretary of defense in the near future, for sure, but I don’t think [the vacancies] had a significant impact over the last six months,” says Marine Corps Gen. Joseph Dunford, chairman of the Joint Chiefs of Staff.

“I don’t believe that there’s been any ambiguity across the force about what they need to be doing.”
NASA Shakes Up Human Spaceflight Management

GERSTENMAIER, HILL REASSIGNED AS ADVISORS
SEARCH FOR SUCCESSORS IS UNDERWAY

Irene Klitz Canevaerlar

When Vice President Mike Pence issued a challenge to NASA to land astronauts on the Moon in 2024, four years earlier than previously planned, he directed the agency to do so “by any means possible.”

That directive sparked a sudden management shuffle on July 10, with longtime Associate Administrator Bill Gerstenmaier replaced on a temporary basis by Ken Bowersox, a former astronaut who helped boot up SpaceX’s human spaceflight program before returning to the agency in February.

Gerstenmaier, who oversaw NASA’s Human Exploration and Operations Directorate, was reassigned as a special advisor to NASA Deputy Administrator Jim Morhard.

Also sidelined in the shuffle was Bill Hill, previously a deputy to Gerstenmaier in charge of human deep-space systems development, including the Space Launch System (SLS) rocket and Orion deep-space capsule. Hill is now special advisor to Associate Administrator Steve Jurczyk, and his previous job has been temporarily assumed by Tom Whitmeyer.

In addition to replacing Gerstenmaier and Hill, NASA Administrator Jim Bridenstine intends to create a new management position to oversee specific elements of the agency’s Moon-to-Mars exploration blueprint. This includes maintaining a professional relationship with a former staff officer, now retired, who has while in uniform been investigated and held accountable over allegations of inappropriate behavior,” Moran says. “To be clear, my decision to maintain this relationship was in no way an endorsement or tacit approval of this kind of conduct. I understand how toxic it can be to any team when inappropriate behavior goes unrecognized and unchecked. Every sailor is entitled to serve in an environment free of harassment or intimidation.”

A U.S. official familiar with Moran’s decision says he resigned because of an association with Navy Cmdr. (ret.) Chris Servello, who worked for Moran when he was chief of naval personnel.

Servello was investigated for his behavior at a 2016 Pentagon holiday party where he was accused of making unwanted sexual advances to women, including junior officers, while dressed as Santa Claus. At the time, Servello was working as the spokesman for Chief of Naval Operations Adm. John Richardson and continued working for the Navy until he retired this spring.

Moran corresponded with Servello during and after the investigation, including communication with him on his personal email account. Richardson will stay until a new chief of naval operations is confirmed, but Richardson cannot serve beyond Sept. 17, when he will have served four years in the position.

This is another in a series of black marks for Navy leadership. In recent years, senior officers were caught up in the “Fat Leonard” corruption scandal and destroyer collisions in the Pacific. The bench is thinning for officers to serve in the top role.

The president has nominated Gilday, a three-star admiral, to lead the service. The last time a three-star officer was nominated to helm the Navy was when Vice Adm. Elmo Zumwalt was nominated for the role in 1970. All three- and four-star officers are eligible for the position, the Navy confirms.

One day later, Trump’s nominee to be vice chairman of the Joint Chiefs of Staff, Air Force Gen. John Hyten, was accused of sexual misconduct. The military investigation found insufficient evidence to charge Hyten, but lawmakers are clamoring for more information about the allegations. It is uncertain whether the Senate will hold a nomination hearing for Hyten.

The Navy’s military leadership is also in limbo. Adm. Bill Moran was Trump’s pick to lead the sea service but declined the presidential appointment. This is bad news for the aviation community because Moran was an aviator during the Cold War—flying the Lockheed P-3 Orion to hunt Soviet submarines. Since then, Trump has nominated Vice Adm. Michael Gilday, who is a surface warfare officer, to fill the vacancy.

“I made this difficult decision based on an open investigation into the nature of some of my personal email correspondence over the past couple of years and for continuing to maintain a professional relationship with a former staff officer, now retired, who has while in uniform been investigated and held accountable over allegations of inappropriate behavior,” Moran says. “To be clear, my decision to maintain this relationship was in no way an endorsement or tacit approval of this kind of conduct. I understand how toxic it can be to any team when inappropriate behavior goes unrecognized and unchecked. Every sailor is entitled to serve in an environment free of harassment or intimidation.”

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failure to meet budget and schedule goals. Lockheed Martin is prime on Orion; Boeing is prime on SLS.

Those reports were far from the first and just the latest to flag a series of missed milestones. Over the years, the GAO, the NASA Office of Inspector General, the Congressional Budget Office and other agencies have sounded similar alarms.

“If you have shareholders and you have to, for example, develop a jet engine for a commercial airliner, and if you don’t deliver, very quickly, that will be reflected in the price of the stock,” Bridenstine tells Aviation Week.

“The government doesn’t operate that way, and we have a tradition of not operating that way. But if we are going to be serious about meeting milestones, we need to be thinking like that,” he added. “We need to have an institution that can say, ‘Hey, our taxpayers are our shareholders, and we will not waste a dollar of theirs. Every dollar we spend will be spent in the most efficient way to achieve the objectives.’”

Bridenstine praises Gerstenmaier, who had served as associate administrator for human spaceflight and operations since 2002, but said it was time for new leadership. “Bill has done great work for the agency and great work for our country. We love him, but as we move forward, we need to be realistic about cost and schedule. When we set cost and schedule milestones, we need to meet them,” he says.

“That’s what we’re moving toward, and it was my assessment that it was time for new leadership. Right now, we have an opportunity to get to the Moon in the year 2024 because of the hard work of Bill Gerstenmaier and what he’s done over the years. It also is true that we have a serious commitment to land on the surface of the Moon in 2024, which requires more adherence to cost and schedule. That’s really what we’re focused on,” Bridenstine says.

A nationwide search is underway to fill Gerstenmaier’s position and two deputy posts. “It could be somebody from within NASA, and it certainly could be somebody from outside NASA. We are not isolating this at all; we want it wide open,” says Bridenstine. “We’re going to look at who the candidates are and try and pick the most qualified person that we believe can help us meet cost and schedule, so that we can get to the Moon in 2024.”

As a down payment for expediting a lunar landing, President Donald Trump’s administration is requesting an additional $1.6 billion to be added to its pending $21 billion fiscal 2020 budget request. Bridenstine estimates that over the next five years the Artemis initiative will require an extra $20-80 billion, perhaps less, depending on commercial and international participation.

“Some commercial companies want to invest as much as 30%—maybe even more—into the project. That helps us if they get selected,” Bridenstine said July 17 to members of the Senate Committee on Commerce, Science and Transportation. “We want to make sure they’re capable of achieving the end state; but at the same time, we are attracted to the fact that private companies want to make this investment.”

Another variable in Artemis’ cost is how much NASA wants to invest in backup systems, so that if one commercial partner falters another can step in and keep the project on track. For example, Bridenstine says he favors awarding three contracts to companies to develop human-class landing systems, then downselecting to two to manufacture the hardware or provide flight services. The company that is awarded the contract could be called on to provide both. “That keeps them all very motivated . . . and it mitigates risk,” he says.

“If something goes wrong with one, the others go forward, and we can stay on schedule.”

NASA adopted this strategy to develop U.S. cargo lines to the International Space Station (ISS), with contracts initially awarded to SpaceX and Rocketplane Kistler. When the latter was unable to meet predetermined milestones, NASA canceled its contract and hired Orbital Sciences, which has since been acquired by Northrop Grumman. Late next year, Sierra Nevada Corp. is expected to begin operating a third U.S. cargo delivery service to and from the ISS with its Dream Chaser winged spaceplane.

NASA is following a similar approach in its Commercial Crew program, with development and astronaut flight service contracts awarded to both SpaceX and Boeing.

Bridenstine says the agency remains committed to using Orion, the SLS and the Gateway to support its deep-space exploration blueprint. The extra $1.6 billion request for the fiscal year beginning Oct. 1 includes an additional $651 million for the overbudget SLS and Orion programs.

Initially, the Gateway will be limited to what is needed to stage a sortie to the lunar surface, reserving $321 million for other Artemis projects. That includes $1 billion to begin work on commercial human-landing systems; $132 million for lunar surface technologies and propulsion systems; and $90 million for robotic exploration and research to support a crewed landing on the Moon’s south pole.

Bridenstine says financial details of NASA’s five-year lunar landing plan will be unveiled with its fiscal 2021 budget request in February. But NASA and the Trump administration will not have to wait that long to get a reading on Congressional support for a 2024 Moon landing: Without a budget agreement in place by the Oct. 1 start of fiscal 2020, or an exemption from a possible continuing resolution (CR), NASA will not be able to meet the deadline.

“If we end up in [a] CR for a period of a year, or even more, it would be devastating for trying to achieve the goal,” Bridenstine told the Senate committee. “With a CR, we do not make investments that we need to make; but even worse, we continue to make investments that we don’t need to make, so it is a waste of money.”

Despite budget overruns and delays, Bridenstine says NASA remains committed to the Space Launch System, on which work continues at the Michoud Assembly Facility near New Orleans.
SpaceX Pinpoints Crew Dragon Abort System Flaw

CHECK VALVES REPLACED WITH BURST DISCS

HOPE DIMMING FOR CREW FLIGHT TEST THIS YEAR

Irene Klotz Cape Canaveral

Check valves normally allow fluids to flow through in only one direction, so it came as a surprise to SpaceX to learn that a slug of liquid oxidizer made it through a valve in a Crew Dragon capsule’s helium pressurization system, triggering an explosion that destroyed the test capsule and delaying a key crew flight test to the International Space Station (ISS).

NASA is counting on SpaceX and Boeing to begin crew ferry flights to the ISS as soon as possible, though program managers caution that safety trumps schedule when it comes to flying astronauts.

**SpaceX’s first Crew Dragon completed an uncrewed trial run to the International Space Station in March and was to be relaunched for an inflight abort test in the spring. The capsule was destroyed April 20, during ground testing at Cape Canaveral AFS.**

Both companies have had technical issues with their spacecraft’s escape systems, intended to fly a crew to safety in case the launch vehicle fails during ascent. During a June 2, 2018, hot-fire test in White Sands, New Mexico, four of eight valves in the propellant system of Boeing’s CST-100 Starliner abort engines, made by Aerojet Rocketdyne, failed to close properly, triggering a leak of hypergolic propellants.

Boeing, which did not publicly disclose the incident until it was reported on July 21 by Ars Technica, traced the problem to a spring system designed to force the two-stage valve closed. The valve did not have enough force to counteract binding inside the valve seal package.

Boeing modified the design of a metal bushing inside the valve seal package to eliminate the binding. After nearly a year of work, the redesigned valve was successfully tested during a second hot-fire test on May 23, clearing the way for a pad abort test and an uncrewed flight test to the ISS later this year.

SpaceX’s Crew Dragon launch abort system flaw revealed itself in a much more public fashion, sending up a cloud of toxic, orangish smoke over Cape Canaveral AFS that was clearly visible to hundreds of beachgoers enjoying a surfing festival at nearby Cocoa Beach over the April 20 Easter weekend.

The helium pressurization system of Dragon’s Super Draco launch abort system was ramping up in advance of thruster firing when an explosion occurred, destroying the vehicle, SpaceX’s Hans Koenigsmann, vice president of build and flight reliability, told reporters during a July 15 conference call.

“We had a leaky component on the system that basically allowed oxidizer to cross over to the pressurization system,” Koenigsmann said. “We believe we had a liquid slug of the oxidizer in that pressurization system.”

Crew Dragon’s eight Super Draco thrusters, which provide propulsion for the capsule’s escape system, use the same nitrogen tetroxide (NTO) oxidizer and monomethylhydrazine fuel as the smaller Draco infight maneuvering engines. The two systems have separate pressurization systems, with Super Draco’s designed for 2,400 lb. psi and Draco’s at 300 lb. psi.

When the valves in the Super Draco pressurization system were opened, the slug of NTO apparently was driven back into the check valve. “Imagine a lot of pressure driving back a slug of liquid,” Koenigsmann said. “It has significant force, and that basically destroyed the check valve and caused an explosion.”

Burn marks found in the recovered valve, as well as analysis of high-speed video and telemetry taken during the test, confirm the scenario. Engineers, assisted by NASA, also conducted tests at SpaceX’s McGregor, Texas, facility, to verify the physics.

“We didn’t quite expect that NTO driven into a titanium component would cause such a violent reaction,” Koenigsmann said. “We found out when the pressure is high, the temperature is high and you drive a slug with a lot of energy into a titanium component that you can have these...
testing is ongoing. “We know enough to know that you should absolutely make sure no oxidizer can move over into the pressurization side and then cause problems when you pressurize the system for flight,” Koenigsmann said.

To that end, SpaceX is replacing the eight Super Draco pressurization system valves with burst discs, devices with no moving parts so they remain completely sealed until they experience pressure that exceeds their rating. The discs then open. “That is basically the functionality we need for the escape system to work properly in case of a vehicle abort,” Koenigsmann said.

He estimates the company is about 80% finished with the accident investigation but declined to take a guess how much time the remaining work will take. “We want to make sure we find all the right corrective actions,” Koenigsmann said. “When you have a test anomaly like this one, you look at other systems; you make sure you don’t have similar vulnerabilities in the same and other systems.

“We also must characterize the basic physics of this: How did this happen, how does NTO and titanium ignite, and what does that mean for flammability? We still have work ahead of us. The hardware (change-out) is probably the smaller part,” he said.

SpaceX had planned to use the Crew Dragon test capsule for a launch abort flight test, followed by launch of a new crewed capsule to the ISS in late summer. Instead, the Crew Dragon earmarked for the test run to the ISS will be used for an in-flight-abort test and the capsule designed for the first operational ISS crew rotational flight was reassigned for the piloted test run. Targeted launch dates are pending.

“My emphasis is really on making sure this is safe,” Koenigsmann said. Asked if the company could make the crewed flight test by the end of the year, he said, “I don’t think it’s impossible, but it’s getting increasingly difficult.”

“We do ground tests so we can learn,” Koenigsmann added. “In this case, we learned a lot—almost more than what we wanted. It certainly is something we didn’t expect and a great lesson for us.”

The European Space Agency and Arianespace have launched an investigation into the Vega launch failure that destroyed an Emirati satellite in July.

For Arianespace, the setback is the second in 1.5 years. In January 2018, an Ariane 5 rocket injected two satellites into the wrong orbit, the result of an erroneous setting. The faulty procedure was corrected, and the next launch took place 2.5 months later.

In August 2014, a Soyuz launcher suffered a mishap, also causing two satellites not to be placed in the desired orbit. The root cause was found in the launcher’s fourth-stage design. The issue was solved swiftly, and the next Soyuz launch from Europe’s spaceport in Kourou, French Guiana, was that December.

With VV15, the situation is more serious, as the launcher’s trajectory ended in the Atlantic Ocean.

Nevertheless, Avio’s Vega has a strong track record for a young launcher, which makes it reasonable to expect that fixing the issue will not involve a major redesign or reorganization. The first 14 missions, since 2012, had been flawless.

The European Space Agency (ESA) and Arianespace have created an “independent inquiry commission” on the failure. It is co-chaired by ESA Inspector General Toni Tolk- er-Nielsen (who led the probe on the January 2018 mishap) and Roland Lagier, Ariane-space’s senior vice president for technical and quality.

The flight was to last 57 min. from liftoff in Kourou to separation of the UAE’s FalconEye1 optical Earth-observation satellite. “Approximately 2 min. after liftoff, shortly after ignition of the Zefiro 23 second stage, a launcher anomaly occurred—leading to the premature end of the mission,” says Arianespace.

The way the Zefiro 23 worked was that December, an Ariane 5 rocket injected two satellites into the wrong orbit, the result of an erroneous setting. The faulty procedure was corrected, and the next launch took place 2.5 months later.

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The failure of the 15th mission of the Vega light launcher (VV15) is unlikely to have far-reaching consequences for launch service provider Arianespace or manufacturer Avio. But the United Arab Emirates (UAE), which had a satellite onboard, is seeing its plans for military Earth observation disrupted. The reversal comes at a time of intense international cooperation for the country’s fledgling space industry.
problem was not with the Zefiro 23 engine’s ignition, she says, but with trajectory control. “If the investigation commission shows there is an issue with the launcher, Vega’s launch schedule may be impacted, but the problem may lie with launch-service provider Arianespace.”

Another two Vega launches were planned for 2019, which would have marked an acceleration in the launch rate.

The loss adds some uncertainty to the upgraded Vega C program. The latest iteration of Avio’s plans for the Vega C called for launching the first one in March 2020. The Vega C’s second stage will use the Zefiro 40, a propulsion system derived from the Zefiro 23. The first fire-test of the Zefiro 40 took place in Italy last year and was successful.

Meanwhile, the UAE’s space policy is facing a hurdle. FalconEye1 was the first of two identical satellites to be launched for the UAE Armed Forces. FalconEye1 and FalconEye2 were planned to operate from sun-synchronous orbit at an altitude of 611 km (380 mi.).

The FalconEye system was designed for very high optical performance. The satellites were to work in tandem with a 70-cm (28-in.) resolution and a 20-km swath. They would have supplied imagery for the military and the commercial market, according to the Emirati government’s plan.

It would take an estimated 12-18 months for Airbus and Thales Alenia Space (respectively, prime contractor and supplier of the high-resolution optical instrument) to build a FalconEye1 replacement. As for FalconEye2, Vega’s schedule called for launching it at the end of 2019.

The UAE has thus far relied on low-performance observation satellites, says Villain. The nation is, in parallel endeavors, procuring advanced hardware for its military needs—which has created links with European companies—and nurturing its own space industry.

Some 50 Emirati companies, institutions and establishments are active in the space sector and employ a combined 1,500, according to Mohammed Nasser Al Ahbabi, director general of the five-year-old UAE Space Agency. They have yet to meet the level of proficiency the military requires. But progress has been swift.

One way to gain expertise has been technology transfer. That was the case with the two DubaiSat Earth observation satellites, says Villain. They were built with South Korea’s Satrec Initiative. The collaboration gave the UAE some autonomy in the development of KhalifaSat 1, placed in orbit last year from Japan.

A partnership with France may help, too. Since October, French space agency CNES has had a representative and space advisor in the UAE. In April, the two agencies reported progress in defining a hyperspectral satellite for joint environmental monitoring.
France’s Aviation Eco-Tax Sets Debate Over How Best To Cut Emissions

AIRLINES SAY THE ECO-TAX WILL NOT HELP THE ENVIRONMENT

SOME EUROPEAN POLITICIANS WANT A EUROPE-WIDE AVIATION FUEL TAX

Helen Massy-Beresford Paris

The French government’s announcement that it will introduce an eco-tax on flights departing from France is just one of a series of measures aimed at reducing aviation’s contribution to climate change either being considered or already implemented at the national or European level.

The move, announced by French Transport Minister Elisabeth Borne on July 9, will undoubtedly have an impact on airlines’ financial performance, already under pressure in a European market characterized by tough low-cost competition, pricing pressure and the economic uncertainty that is hitting consumers’ spending power. But will it even help lower emissions?

“This will not weigh on airlines’ cost but rather make air travel more expensive, weighing on demand at a time when European demand is weakening anyway,” Bernstein analyst Daniel Roeska wrote in a July 10 research note.

With strong growth in air traffic predicted—the International Air Transport Association (IATA) expects a doubling globally to 8.2 billion passengers in 2037—and aviation accounting for around 2% of global carbon dioxide emissions, politicians, industry executives and climate campaigners who disagree on the way forward, do agree that something needs to be done.

Pressure is growing to end the tax exemption kerosene has enjoyed since the 1944 Chicago Convention mapped out the framework under which modern aviation still operates.

The Dutch and French governments are among those calling for a Europe-wide aviation tax, arguing that the exemption dates from a time when carbon emissions and environmental concerns were not on the radar but encouraging the development of international commercial aviation was the priority. A meeting of European ministers to discuss aviation taxation and carbon pricing took place in the Netherlands last month.

Environmental campaigners who do not necessarily see the value in a straightforward eco-tax like the French one—which applies regardless of the efficiency of the aircraft—say that imposing a broader, Europe-wide tax on aviation fuel could encourage an acceleration of industry efforts to invest in modern, fuel-efficient aircraft and initiatives to reduce fuel burn.

It would also give airlines an incentive to make sustainable biofuels and electric and hybrid aviation true alternatives in the longer term.

A leaked European Commission (EC) report published in May apparently showed that imposing a fuel tax on all departing flights to all destinations at the €0.33 ($0.37) EU energy tax minimum would cause ticket prices to rise 10%, flights, passengers and CO₂ emissions to fall 1%, the number of people affected by noise to drop 8% and fiscal revenues to rise from €10 billion to €27 billion. But environmental group Transport & Environment said the study showed taxing aviation fuel would have no net impact on jobs or the economy.

The EC declined to comment on the report at the time, saying only that it is in the process of reevaluating the Energy Taxation Directive, which governs how fuels and energy products including aviation fuel are taxed, to see if a potential update is necessary.

The directive currently allows European member states to exempt aviation fuel for domestic, intra- and extra-EU flights from taxation. EU member states are free to tax aviation fuel used for domestic flights, or intra-EU flights provided there is an agreement between the departing and arriving countries.

But as she announced the French eco-tax move, Borne spoke about the need for urgent action. The levy will apply to all airlines with flights departing French airports—with the exception of connecting flights and those to Corsica and overseas French territories—and will be calculated progressively, with a €1.50 contribution for an internal or intra-European service in economy class rising to €18 for a business-class seat to a non-EU destination.

“France has committed to getting Europe to make progress on an air transport tax,” she said. “The awareness is there now, and things are starting to move—but it’s urgent, which is why we have decided, as other countries have, to put in place an ‘eco-contribution’ on all flights departing from France.”

The French eco-tax mirrors similar taxes in place in Germany and Sweden and planned in the Netherlands and has, perhaps unsurprisingly, been widely criticized by the industry. IATA dubs it “misguided,” and airlines argue that it won’t have the desired effect of reducing CO₂ emissions and that the priority should be to encourage investments in aircraft, technology and fuels that can make the aviation sector greener.

In Europe, airlines say they are already making environmental contributions. Industry group Airlines for Europe (A4E) says European airlines are set to pay over €5 billion in environmental taxes in 2019. That will include a €50 million contribution through the EU Emissions Trading Scheme, while the global carbon offset scheme Corsia
Roeska wrote in a July 10 research note.

But will it even help lower emissions?

July 9, will undoubtedly have an impact on airlines' financial performance, especially in the Netherlands last month.

Over how best to cut emissions?

Some European politicians want a Europe-wide aviation tax, arguing that Europe-wide aviation still operates.

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France has committed to get 50% of flights to arrive in their border airports from 2022.

The Race Is On: eVTOL Vehicles Take Flight

The world’s leading eVTOL flying car and flying taxi manufacturers reveal their unique plans and current vehicle status for the future of flight. With Ehang and Volocopter.

Battery Power & Propulsion Technologies

Hybrid electric propulsion systems and all electric technologies are enabling the emergence of eVTOL vehicles and a new era in aviation. Our panel of industry experts provide an overview of the progress, power and reliability of distributed electric propulsion system designs and what the future holds.

Transforming Mobility: Safety, Regulation, and Certification

The Asia-Pacific region has established itself as a pioneer when it comes to regulatory acceptance and encouragement of urban flight tests for eVTOL vehicles. This session will dive into the regulatory path to market for the region, including potential challenges ahead and opportunities for collaboration between industry and government.

From the Ground Up: UAM Infrastructure Planning and Development

As we try to navigate and understand a new urban environment and the evolving and ever-present role of smart city applications, we discuss what strategies, testing and validation needs to be undertaken to get the buy-in of local officials, airports, businesses, developers and urban planners.

Conference will conclude with a Networking Reception.

Aviation Week’s UAM series brings together manufacturers, regulators, technology innovators, disruptors, municipal leaders, and the infrastructure & investment community; all working together to create on-demand aviation for smart cities and a new future for manned and unmanned air transportation.
will result in the mitigation of around 2.5 billion tons of CO2 between 2021 and 2035, the industry group says.

The A4E airlines argue that taxing aviation will prevent carriers and the broader industry from investing in modern, fuel-efficient fleets—and that encouraging the development of more sustainable aviation fuels is a better way to fight the impact of air transport on the environment.

Ryanair CEO Michael O’Leary, who is also A4E chairman, told a July 10 A4E press conference in Brussels that the French eco-tax was “yet another unjustified tax on air travel” and insisted that, contrary to criticisms leveled against the industry, “aviation in Europe does not get a free ride [on taxes].”

Ryanair paid €544 million in aviation and environmental taxes in 2018, with air passenger duty making up a large part of that—and overall, Ryanair’s passengers pay more than 10% of their ticket price in environmental taxes, O’Leary said.

He described additional aviation taxes as “a knee-jerk reaction” that will harm competitiveness and connectivity within Europe.

A growing number of separate tax measures could pose problems for airlines, Bernstein’s Roeska wrote: “Air travel is an easy target for more taxation. Airlines will need to be careful to prevent multiple cost increases for their passengers through conflicting and unaligned programs.”

Willie Walsh, CEO of International Airlines Group (IAG), the parent company of Aer Lingus, British Airways (BA), Iberia, Level and Vueling, also criticized the way in which existing taxes are used. “Last year, BA paid €850 million in air passenger duty. Not a single cent of that money went to improving the environment,” he said at the A4E event.

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**Asian Airlines Seek Benefits From Strategic Partnerships**

> **NEW METAL-NEUTRAL JOINT VENTURES ARE LAUNCHING THIS YEAR**

> **SOME AIRLINES ARE INVESTING IN PARTNERS TO ENHANCE LINKS**

Adrian Schofield Auckland and Seoul

The competitive dynamics of the Asia-Pacific airline industry are shifting this year, as some of the region’s major players look to strengthen their positions by increasing their cooperation with other carriers.

Asian airlines have very few opportunities to consolidate due to cross-border ownership and control restrictions. The full-service giants are also more limited in their ability to set up offshore franchises, in contrast to low-cost carriers that are spreading their brands across the region.

Because of this, the legacy airlines are increasingly looking for other ways to benefit from international relationships. In many cases, this means applying for regulatory permission to form metal-neutral joint ventures in key markets and even cementing bonds by investing in their allies.

Among the strategic partnerships that have emerged or expanded this year are those between Malaysia Airlines Berhad (MAB) and Japan Airlines (JAL), MAB and Singapore Airlines (SIA), JAL and Hawaiian Airlines, and All Nippon Airways (ANA) and Philippine Airlines (PAL). Delta Air Lines has also strengthened its bond with Korean Air by buying a stake in its partner.

Recent moves involving MAB are particularly significant, as the carrier is looking to new strategic partnerships as a key plank in its revised turnaround plan. The Malaysian government is assessing the turnaround plan as well as other options for the state-owned airline’s future.

MAB and JAL applied in April for regulatory permission to enter a joint business agreement (JBA), and are waiting for approval. While the two airlines already codeshare, they want to form a metal-neutral operation on routes between their respective countries, and have signaled their cooperation could be expanded to other markets and areas of business.

The JAL deal is “strategically important,” and represents the first JBA for the Malaysian carrier, MAB CEO Ismail Izham told Aviation Week at the International Air Transport Association annual meeting in June. However, he stressed that MAB wants to form more joint ventures and is in discussions with a few other airlines.

One of the most important elements of the partnership will be knowledge sharing, Izham says. He notes that JAL went through a major bankruptcy restructuring and recovery effort, and MAB will be able to draw on the lessons learned by the Japanese carrier. Employee exchanges will help with that process.

JAL President Yuji Akasaka agrees that JAL’s experience with a successful turnaround could aid MAB as it plans its own recovery. JAL is the partnership because it believes “there is a lot of potential for MAB going forward,” Akasaka says.

There is also the potential for JAL to take the partnership a step further by investing in MAB. Akasaka says that the investment question is “still under review,” and he indicated that discussions will be conducted on this topic.

In a subsequent alliance move, MAB announced a tentative agreement with Singapore Airlines to enhance the partnership between the two airline groups. The carriers signed a memorandum of understanding to this effect on June 27.

Subject to regulatory approvals, the deal will be finalized in the “coming months,” according to a joint statement. An SIA spokesman says that “specific details” of the agreement will be revealed when it is completed. However, he did confirm that it will not involve investment by SIA into MAB.

This closer relationship is notable due to the history between the two airlines. Singapore Airlines and Malaysia Airlines had the same parent, Malaysia-Singapore Airlines, but it was split into two in 1972.

While few details have been revealed, the carriers say they will expand existing codeshare arrangements between the two countries. The Singapore-Kuala Lumpur route is one of the world’s busiest international city pairs. The airlines may also add codesharing beyond the Singapore-Malaysia mar-
Air France, set to be the hardest hit—although the exemption of connecting flights will soften the blow somewhat—said it “strongly disapproves” of the eco-tax, which it says will cost it over €60 million a year and which comes on top of taxes French airlines are subject to that their European counterparts are spared.

The airline, which operates 50% of its flights out of France and incurred a €180 million loss on its domestic network last year, said, “This new tax would significantly penalize Air France’s competitiveness at a time where the company needs to strengthen its investment capacity to more rapidly reduce its environmental footprint, notably as part of its fleet renewal policy.”

EasyJet, which flies 20 million passengers to and from France every year, will see a significant impact from the tax. “We don’t think any additional aviation tax on the passenger is the right approach,” the airline states. “The way for aviation to address climate change is to invest in new technology. A tax would take away money from this investment and only have a marginal effect on emissions.”

The UK budget carrier says it had reduced its carbon emissions per passenger-kilometer by over 32% since 2000, to 78.46 grams in 2018.

The proceeds of the French eco-tax will be invested in alternative forms of transport, another bone of contention for airlines which say the aviation industry needs support and encouragement to improve its own environmental credentials.

“A tax will not help the industry to invest in cleaner fuels and technology,” IATA says. Roeka added that the eco-tax “does not introduce any incentive for airline operators to advance decarbonization and is not tied to emission levels.”

Forming strategic alliances with other carriers such as Japan Airlines and Singapore Airlines is an important part of Malaysia Airlines’ turnaround strategy.

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Mitsubishi Sees Path to Success for Its Smallest Regional Jet

NEW VERSION WILL SEAT 76 AND MEET U.S. SCOPE CLAUSES
WING MODIFICATIONS ARE KEY FOR WEIGHT AND PERFORMANCE

Sean Broderick Le Bourget and Washington

> Mitsubishi Aircraft Corp. (MITAC) is betting on healthy doses of engineering and marketing to transform the smallest version of its new regional jet (RJ) family into an ideal fit for U.S. airlines that must comply with strict contractual limitations without sacrificing much-desired cabin comfort.

MITAC's newly rebranded SpaceJet M100 will be what Chief Development Officer Alex Bellamy calls an “optimized” version of the MRJ70, the original family member that targeted the U.S. market. But that aircraft was designed under the assumption that scope clauses—agreements between major airlines and their pilots that limit regional aircraft capacity and takeoff weights—would loosen during the next round of pilot-contract talks. With a few exceptions, current rules dictate that regional aircraft—and more important, the lower-wage regional pilot pay scale—top out at 76 seats and a maximum takeoff weight of 86,000 lb. It has become clear that those restrictions will not change anytime soon, so MITAC must.

“We have no choice but to adjust our strategy,” Bellamy says. “We have no choice but to adjust our strategy.”

U.S. airlines want their regional aircraft cabins to be as close as possible to their mainline products while maximizing capacity meaning 76 seats and a first class are de facto musts for large RJs. Bombardier's CRJ700 is scope-compliant but is ending its production life. Among the inclusion of “space” in the new SpaceJet brand name.

Morphing the MRJ70 design into the M100 also includes changing the canted wingtip design, shortening the span by about 4 ft. to just more than 91 ft. Much of the resulting performance reduction will be made up in other areas such as reducing drag. Bellamy says, leaving the M100 capable of flying “99.5%” of today's regional routes. More important, the modified winglet will reduce wing load, creating the opportunity to remove stiffeners that the MRJ70's wing required—one of several weight-reduction steps that MITAC partner Triumph Group is undertaking to keep the aircraft within scope-clause limits.

Triumph's structural optimization efforts focus on three areas: the wing, aft fuselage and empennage. The company's assignment is to remove 15% of the overall structural weight. After just a few months on the job, Triumph is confident it will deliver.

“We've already identified a path to get that weight out of the structure,” says Triumph Aerospace Structures Executive Vice President Pete Wick.

“We actually believe that we may well be able to get more.”

Triumph is no stranger to aircraft design optimization, having purchased longtime suppliers like Vought Aircraft in 2010 and folded it into its aerostructures business. More recently, it manufactured wings for the Bombardier Global 7500 (G7500) before selling the operation to the Canadian manufacturer.

Wick points to G7500 wing certification testing as an example of his company's capabilities. Triumph's finite element-model pinpointed where the wing would break, and how far above limit load—the maximum load expected during its service life—the failure would take place. The model was correct, right down to the exact percentage beyond limit load that the wing broke.

“What that tells you is, our modeling methods produce optimized structures,” Wick says. “We’re able to identify all the opportunities to remove unnecessary weight, to ensure that you don’t have an overengineered structure.”

The wing area has the most potential. Besides removing unneeded stiffeners, plans call for modifying the engine pylons and wingbox.

The wing changes bring more than weight-reduction opportunities.
Bellamy says the new dimensions make the M100 more compatible with current RJ gate facilities as well as compliant with a 95-ft. wingspan maximum in place at Colorado’s Aspen-Pitkin County Airport, a popular tourist destination. The airport’s configuration, including the separation between its single runway and taxiway, requires special, FAA-approved restrictions.

The M100 will be one of the few regional aircraft with the wingspan and performance characteristics to operate into Aspen. The only other RJ in production that can do so is the CRJ700. Thanks to a deal announced June 25, it will become part of the MITAC family. MITAC parent Mitsubishi Heavy Industries is purchasing the CRJ program. Bombardier is ending new CRJ production in 2020. Besides adding an established global product-support operation, the move gives MITAC direct access to CRJ customers that may need to replace aging airframes in the next decade or want to modernize their fleets with a newer design.

MITAC used the recent Paris Air Show to unveil its new cabin mock-up. It also unveiled a memorandum of understanding from an unidentified North American carrier for 15 M100s. The deal sets the stage for “formal negotiations” to begin for a firm order that would see deliveries begin in 2024, when the M100 is expected to enter service, the company says. The larger M90—the former MRJ90—is on pace to be certified by Japanese regulators and enter service with launch customer All Nippon Airways next year. An even larger M200 is on the drawing board, and plans call for transferring as many M100 design improvements as practicable to the rest of the family.

Despite several major setbacks that have led to years of program delays, MITAC is bullish about the SpaceJet’s current position.

“We have several major campaigns that we’re working on in the U.S. and several major campaigns we’re working on in Europe,” Bellamy says. “We think there’s plenty more to come.”

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**Emirates Fleet Changes Trigger Dubai Hub Transformation**

> MORE OFF-PEAK FLYING WOULD EASE CONGESTION

> AIRPORT OPERATOR LOOKS AT FURTHER WAYS TO INCREASE PASSENGER THROUGHPUT

**Jens Flottau** Frankfurt and Paris

When it became clear late last year that Emirates and Rolls-Royce would not reach an agreement on performance guarantees for the Trent 900 engines powering a future fleet of A380s, Airbus had to make the painful decision to end production of its biggest commercial aircraft. The move also put an end to the idea—at least for now—that growth in air travel will force airlines into operating very large aircraft.

Emirates’ hub at Dubai International Airport (DXB) is a unique operation. The airline has a fleet of 268 widebodies, among them 110 A380s. With very few exceptions, every Emirates flight either takes off or lands at DXB. Emirates took the concept of connecting widebody services to other widebodies to the extreme in early July by putting an A380 on the Dubai-Muscat market twice daily. At 349 km (215 mi.), the route is the world’s shortest scheduled A380 service. Emirates Airline President Tim Clark used to call such deployments—there are other short A380 flights in the network—an “intelligent misuse of capacity.” But that misuse will become less common in the future. Emirates’ slow move away from the A380 and new focus on smaller widebodies will have major consequences for the future composition of its network and how the Dubai hub can function.

As part of its A380 termination deal, Emirates placed a preliminary order for 40 A330-900s and 30 A350-900s. It also announced its intention to buy 40 Boeing 787-10s at the 2017 Dubai Air Show and has a firm order in place for 150 777Xs. The final composition of the Boeing deal is being renegotiated and may end up looking substantially different.

Clark argues that Emirates is now taking aircraft that came to market after it had proved to others that unserved markets existed between many city pairs and that were initially connected through Dubai on large aircraft like the A380 and 777. Those city pairs “are now being served with nonstop flights,” he says.

Emirates will use the smaller widebodies for “ultra-long-haul routes from Dubai that cannot be justified with the 777X or A380,” Clark notes. “There are a lot more cities that we can [serve]
in the U.S., India and Africa with a 250-seater.” Emirates will also “increase production on existing routes” and expand its network into Latin America, he says. There remains an important long-term role for the A380s, nonetheless. They still provide “enormous market pull,” Clark says, and are operated at high load factors in the premium cabins in particular. “We will continue to invest in them and fly them into the mid-2030s,” he adds.

“The Emirates fleet decision] puts more pressure on the capacity elements of airports and air traffic control, but it is also an opportunity,” Dubai Airports CEO Paul Griffiths says.

Griffiths expresses confidence that DXB can deal with the new fleet structure under certain conditions. “We only need more stands if we operate in the same way,” concentrating most flights in peaks, he says. “But if frequency wins over capacity, it also means less peak demand. You don’t have to concentrate on peak times.”

To accommodate the additional frequencies “we need to spread the demand to more connecting [flights] throughout the day,” Griffiths says.

The airport is also looking at different processes to speed up turnaround times. “We look at this very seriously,” he asserts. “Why does a separate van deliver blankets [to the aircraft]? We need a high-speed internal ground network through which containerized supply is pushed out.” Griffiths wants more “just-in-time mentality” to be introduced at the airport.

Even if aircraft movements are more spread out and less focused on peak times, Griffiths says “schedule regularity becomes so much more important,” arguing that therefore, a “step change in reliability needs to be facilitated.” Also, better planning of aircraft placement at specific gates is crucial as “one of the enemies of connecting is walking distance,” he says.

DXB handles 89 million passengers a year. Griffiths expects passenger numbers to grow to 120 million by 2022. Even with additional capacity measures planned, including a new concourse between Terminal C and D gates for remote stands, 122 million passengers is “the absolute ceiling” of what the airport can handle, he says.

To accommodate the additional frequencies “we need to spread the demand to more connecting [flights] throughout the day,” Griffiths says.

Dubai International Airport will hit its capacity limit in 2022.

900. Clark told The Seattle Times he is negotiating with Boeing for “a combination of the 150 777Xs and the 40 787s, essentially looking to keep the numbers in place, but substituting and spacing them out over a longer timeline.”

Emirates’ 777X order represents close to half of that model’s firm order backlog, which stands at 344 aircraft. Boeing has 173 firm orders for the 787-10. Emirates and other customers face a potential delay in deliveries of the 777X because of newly emerged problems with its GE9X engines. Emirates could mitigate the effects by extending leases for its existing 777-300ER fleet and phasing in the A330neos and A350s.

Emirates said in 2017 it would start taking delivery of the 787s in 2022. The A330neos are to begin arriving in 2021 and the A350s in 2024.
The French air accident investigation office (BEA) has discovered that a serious incident involving an Airbus A340 in 2017 was only the tip of the iceberg. The investigation highlights the value of flight data monitoring and that pilot training is facing a challenge in refining takeoff techniques.

The BEA determined that some abnormally long Airbus A340-300 takeoffs from Bogota El Dorado International Airport in Colombia were due to improper pilot inputs. The events—at least two—involved Air France-operated aircraft, but the carrier's cooperation with Lufthansa demonstrated that the problem was not specific to the former.

A340-300 pilots tend not to pull the control stick backward enough at takeoff, according to the BEA. The incident pilot himself was pulling even less than the average.

Bogota’s airport is located at an altitude of 8,360 ft. in a mountainous environment. The takeoff run available on the day of the investigated incident (March 11, 2017) was 3,800 m (12,470 ft.), followed by a 300-m clearway.

Despite thorough preparation, the flight began with a dramatically long takeoff run and shallow climb. Lift off took place 140 m before the opposite threshold, and the end of the clearway was overflown by a mere 1.8 m.

According to the BEA, the actual takeoff distance on that day was 424 m over the accepted standard, which includes safety margins.

Airbus used Air France data to study A340-300 pilot practices, says the BEA. In the flight crew training manual, the airframer recommends the pilot apply a two-thirds deflection to the sidestick at rotation speed (VR). This is supposed to be the right procedure to quickly reach the expected 3-deg.-per-second rotation rate (see green curve on the graph).

However, the average Air France pilot makes a smaller deflection, resulting in less than 2 deg. per second (see blue curve). Airbus calculated this translates into an additional 200 m to liftoff. The problem is the same with Lufthansa.

In the March 2017 incident, the pilot’s input on the sidestick (red) was softer than the Air France average (blue) and Airbus’ model (green).

During the March 11, 2017, event in Bogota, the pilot made an even softer input at VR. The pitch angle was therefore dangerously low (see red curve in graph) at takeoff and for the initial climb.

Given the operating conditions on the day of the incident, what may be more disturbing is that Airbus’ simulation shows the recommended two-thirds deflection was inadequate. “The pilot should have applied, at VR, an initial input of more than 80% of the maximum deflection,” says the BEA. With the 3-deg.-per-second rotation rate, the simulation yielded a takeoff distance that used 67% of the mandatory safety margin.

Airbus has consistently highlighted the risk of tailstrike. BEA investigators believe this may have influenced A340 pilots in their rotation technique.

Moreover, estimating a rotation rate is difficult, according to Vincent Gilles, vice president of the SNPL France ALPA pilot union. “If you are focused on your takeoff, you cannot measure precisely that you reach the desired pitch angle in the required 4 sec., but it should be doable to train for this in a simulator.” Airbus test pilots should spend more time correlating the input with the rotation rate, he adds.

Air France and Lufthansa have added safety margins into the procedure in Bogota. Air France crews have also been retrained in rotation techniques. As a result, takeoff distances have decreased, but they remain above the airframer’s model, the BEA notes.

Lufthansa chose not to teach its pilots to increase the rotation rate at takeoff, citing a risk of tailstrike.

Airbus’ documentation no longer includes a typical value for the backward stick input. The manufacturer would rather focus on the rotation rate, which itself should depend on a given day’s conditions.

The BEA recommends the European Aviation Safety Agency and Airbus reestablish consistency between the certified takeoff performance and actual operations. In any case, “this cannot be exact science; you have to take safety margins and monitor operations,” Gilles notes. Could that flight phase be automated? No, as the human being has the big picture and the computer does not, according to Gilles. “If the pilot sees a flock of birds on the intended trajectory, he will slightly delay rotation,” he adds.
The future took the captain’s seat at the world’s largest aviation gathering, the annual Experimental Aircraft Association AirVenture convention at Oshkosh, Wisconsin, from July 22-28, where several manufacturers showed that battery power is viable for light aviation.

Leading the pack is Slovenia’s Pipistrel, which has been developing electric aircraft since 2007 and began deliveries two years ago of the world’s first production model, the two-seat Alpha Electro. With nearly 60 now in service worldwide, the company expects demand from U.S. flight schools to take off when the FAA joins the rest of the world in allowing electric propulsion in light sport aircraft (LSA).

“The FAA is going to revise it. It’s in full motion and coming quickly,” says EAA Chairman and CEO Jack Pelton. FAA Acting Administrator Dan Elwell visited numerous exhibitors to discuss rules for allowing electric LSAs, as well as the goal of expanding the category by raising the gross-weight limit, which would allow four-seat aircraft to be flown with a sport pilot license instead of a full airmen’s certificate.

There are nine Alpha Electros in the U.S., certified as experimental aircraft rather than LSAs, and several are used for flight training under an exemption to their operating rules. But this is temporary, and the rule change is needed for the future, Pipistrel says. “We’re the only ones that are selling a proper production aircraft,” says distributor Michael Coates. “There are lots of people out there making promises of setting the world on fire,
but we’re the only ones that have real aircraft you can buy now and use.”

With a low cost of operation, electric light aircraft are seen as one solution to increasing demand for pilot training. Manufacturers of conventional piston-powered training aircraft are already enjoying rising sales. Demand for Piper Aircraft’s Pilot 100 and 100i trainers has far exceeded expectations, says President and CEO Simon Caldecott, with U.S. flight schools signing purchase commitments for more than 100 aircraft since the lower-cost models were introduced in April.

Training aircraft sales at AirVenture included 50 Pipistrel Alpha Trainers and up to 100 Cessna Skyhawks. In addition, Pipistrel announced the Alpha King trainer equipped with BendixKing’s XVue Touch cockpit, while Continental Aerospace Technologies unveiled a drop-in replacement engine for some Lycoming-powered Cessna Skyhawks, and BendixKing introduced a cockpit upgrade for single-engine Cessnas.

Battery-powered aircraft are still limited in flight time, and Pipistrel plans to fly a hybrid-electric prototype by year-end. Aeromarine LSA introduced its single-seat Electrolite PSA (personal sport aircraft) at Oshkosh, and CEO Chip Erwin says battery power is well-suited to an ultralight that flies low and slow and goes nowhere for 45 min., but for longer range or speed, hybrid power is needed.

The Electrolite has several novel features, including dual control by radio from the ground. An instructor on the ground can take control of the aircraft at any time and monitor the pilot and aircraft on a laptop or large screen via airborne cameras and sensors. This offers a safe solution for training a pilot in a single-seat aircraft, Erwin says, insisting it is not a drone and flies legally as an ultralight so long as there is a person on board.

Cirrus Aircraft’s new CEO, Zean Nielsen, believes it might take another decade before the company’s class of fast, long-distance general aviation aircraft could go electric instead of gasoline-powered. “The weight and power density are not there yet; the batteries are so heavy. If you want to go any meaningful distance, you’ve got to have a big battery,” he says.

Underlining the link between hybrid and performance, XTI Aircraft announced at AirVenture that it has selected GE Aviation’s Catalyst turbo-prop as the basis for the hybrid-electric propulsion system in its planned TriFan 600 vertical-takeoff-and-landing (VTOL) business aircraft. Continental, meanwhile, has teamed with VerdeGoAero to provide diesel-cycle engines for hybrid-electric distributed propulsion systems for VTOL urban air mobility (UAM) vehicles.

While UAM had its own pavilion at Oshkosh, neither the UAM booth nor the drone-flying cage seemed able to draw attention away from the Innovation Pavilion that housed numerous small companies developing mostly single-seat personal aircraft. This was very different from two years ago, when drones were the flavor of the day.

Seven of the finalists in the $2 million global GoFly Prize competition to develop personal flying vehicles were at AirVenture as they prepare for the final flyoffs in February 2020. GoFly Prize CEO Gwen Lighter is delighted with the response to the competition. “Everyone realizes that this really is a golden moment in aviation where we have the tools to make the dream of pure human flight a reality,” she says.
Learned Behavior

> EXPLAINABLE AI IS KEY TO CERTIFIABLE MACHINE LEARNING

> FROM DESIGN TO COMBAT, AI IS LIKELY TO AFFECT AIRCRAFT

Graham Warwick Washington

From concept exploration to autonomous combat, artificial intelligence (AI) is being introduced into new areas of aerospace and defense. Machine learning has already enabled rapid strides in data analytics, but the next steps could have even greater impact, from how aircraft are designed and manufactured to how they are crewed and flown.

“It’s already impacting every dimension of our business, and that impact will continue to grow,” says Boeing CEO Dennis Muilenburg. Experts within the company’s AnalytX organization, formed in 2017, are already applying AI to supply chain and manufacturing system management and engineering toolsets. “We also see it working into our product lines themselves, into the systems on our airplanes,” he says.

But there are barriers to be overcome before AI can take flight. “To get something safety-certified, you have to be able to predetermine what the machine will do in a scenario, and AI isn’t deterministic in that regard,” says Collins Aerospace CEO Kelly Ortberg. “We are going to have to continue to work that boundary of how does inherently nondeterministic AI apply in a deterministic certification world.”

Airbus, Boeing, Lockheed Martin and others are experimenting with onboard AI, but the research is in its infancy. “I don’t think you’re going to see AI flying airplanes independently in the near future,” says Ortberg. “I think it may become a supplemental tool, but there still has to be an overarching deterministic system that determines, under failed conditions, what the airplane does.”

For now, AI in aerospace means statistical learning. “I’m not a believer that artificial intelligence really exists right now,” says Raytheon Chief Technology Officer Mark Russell. “I would say there will come a day when you can do more with it than just ingest large amounts of data and sort things out and help make decisions. There will come a day when machine learning actually gets to the right fidelity and is more deterministic.”

It is not only the nondeterministic nature of AI that poses a problem for aerospace. Today’s machine-learning systems are immensely powerful at statistical pattern recognition when trained to sift through enormous amounts of data, but they cannot explain their decisions. Without an explanation to back a prediction, users cannot build the trust needed for AI to secure a place alongside the human.

“There are a lot of different approaches to AI, and most of them are ‘black box’ today. You train a multilayered convolutional neural network, but then you have no idea what that neural network will or will not do in the future,” says Paul Eremenko, United Technologies Corp. chief technology officer.

“You can get statistics, but on today’s certification basis, it’s not explainable. You cannot tell why it’s doing what it’s doing,” he says. “So alternative approaches to AI that are explainable, and therefore certifiable, and that also provide much better human-machine collaborative capability, are the key for the longer term.”

Because of the complexity inherent in machine learning, explainability will be key to customers accepting systems. “You can’t go through the code and say, ‘I can validate this,’” says Russell. “There’s a whole ‘How
do we test?’ thing. Right now, when you're done with so many neural networks, and there are so many things going on that you can’t debug, you can’t really know what happened. At some point, we’re going to have to come up with a way where we can actually understand what happened.”

To that end, DARPA has launched its AI Next campaign with more than $2 billion in funding over five years. Developing explainable AI is a key goal, along with creating systems that can learn from experience while operating in the real world, reducing the number of manually labeled examples required to train a neural network and defending against misclassification attacks on networks.

DARPA has a long involvement with artificial intelligence, beginning in the 1980s with the first wave of AI involving expert systems. These encoded the knowledge of subject-matter specialists in the form of handcrafted rules. An example was the Pilot’s Associate program to develop a decision-support system to help the pilots of single-seat fighters.

“Unfortunately, for every rule there's an exception,” says DARPA Director Steve Walker. “Expert systems are brittle when confronted with situations that don't conform to their rules, and adding a new rule to account for every exception quickly becomes intractable.”

The second wave of AI focused on building neural networks, inspired by the human brain, and training them with large numbers of labeled examples. “Starting in 2010, sufficiently powerful computer hardware became available to make these approaches work surprisingly well,” Walker says.

“Like first-wave expert systems, however, second-wave systems have shortcomings. Adding imperceptible amounts of noise to a picture can cause a trained neural network to wildly misclassify it,” he says. “So far we only have point solutions to such adversarial image attacks, as the practice of machine learning has run well ahead of the theory.”

DARPA’s Explainable AI (XAI) program is developing computational architectures that enable neural networks to explain themselves. “The knowledge of neural networks is contained in millions of link-weighting factors, making these systems incapable of explaining their decisions,” says Walker. “[Explainable AI] will help human operators develop appropriate levels of trust in their systems.”

The inability of machine-learning systems to provide the justification for a specific prediction “can leave the user frustrated, particularly if they’re responsible for critical applications,” says David Aha, XAI program manager. XAI is creating machine-learning processes that output an explainable model, with an interface that allows the user to interrogate that model, and know when to trust the system.

XAI is focused on two types of application: data analytics and autonomous control. An example of the first is an intelligence analyst working with a machine-learning system that is responsible for looking at imagery, identifying certain objects and activities and recommending how to respond to what it sees.

The research is showing that hidden biases within machine-learning algorithms can lead to misleading predictions such as identifying a shopping mall as a solar farm because the network is paying more attention than the user realizes to features such as a parking lot, which complicates the prediction.

“In terms of autonomy, we have operators who are interested in why certain actions are being taken by an autonomous vehicle,” Aha says. The vehicle might be out of sight, with access to information the operator cannot see, so they want to be able to interrogate the model to understand the behavior.

XAI aims to increase explainability without sacrificing learning performance. When working with sensor data, deep-learning models have been shown to greatly increase performance, “but often it has been at the sacrifice of explainability,” he says. “The goal is to create AI systems that are machine-learning enabled, in which users can understand the learned model, why the predictions are being generated, when they need to trust the model and work with it effectively.”

In another XAI project, involving self-driving cars, vehicle control commands generate text explanations of the model’s actions. “What they’ve found is that, given explanations, the humans are doing much better. There’s also evidence the explanations have engendered appropriate trust in the system,” Aha says. “One drawback is that, if the system provides an incorrect explanation, it can be very damaging.”

DARPA is pushing AI into new areas. One is software production, where not only is the amount of code in systems increasing, but also the portion of critical functionality realized in software. “A parallel and not so exciting trend is that the defects or vulnerabilities on software are also increasing at the same time,” says DARPA program manager Sandeep Neema.

Tools and methods for software production and quality assurance are not scaling up with the amount of code needed, he says. And software engineers are unable to effectively utilize the large codebase that exists today to understand the source of bugs and make sure they are not repeated.

One answer, says Neema, is to treat software programs as data for machine learning. DARPA is developing new capabilities in code mining, bug detection and program synthesis. The goal is to enable engineers to easily search existing databases for usable code, apply learning-based approaches to anomaly detection, and generate program artifacts with minimal specifications.

DARPA is also applying AI to design. “I'm focused on the earlier stage of design, because that is still very artisanal, and the question I’m asking is: How can AI help us explore all the different possibilities that are actually available?” says program manager Jan Vandenbrande. “There are so many options available; can we have AI explore all of these combinations to find really new, novel things?”

Researchers have trained a deep neural network with observational data on flow around a cylinder and used it to generate equations governing physical behavior. The result closely corresponds with the Navier-Stokes equations that describe viscous-fluid motion. “So can we train a neural network to discover other physical laws we haven’t thought about?” Vandenbrande asks.

“What this may create is Newton in a box, where you give it the observational data on the proverbial apple falling and the outcome is F=ma.”

Under another program, researchers combined reinforcement learning with a physics engine used in gaming
AI is still a long way from replacing the human designer, says Aha. “To do design you have to know how the world works. As humans, we don’t go all the way back to first principles. We have all these shortcuts in our mind, and we’ve learned this over years,” he says. “The question is, how can we discover all these shortcuts using some kind of AI?”

Aha sees the future of AI-enabled design as a partnership where the human’s responsibility is problem formulation—“this is what I am looking for; these are the constraints”—then the AI searches the design space and comes back with, “here are some ideas you should explore.” “I believe this becomes a dialog between the computer and the human, and the human gets insight from the AI and changes the problem formulation,” he says.

When it comes to applying AI to autonomy in combat, interaction with the human becomes a critical issue. Describing air-combat training as a crucible where pilot performance and trust are highly refined, DARPA says its Air Combat Evolution (ACE) program will use human-machine collaborative dogfighting as a challenge scenario to increase pilot trust in autonomous combat technology. “Being able to trust autonomy is critical as we move toward a future of warfare involving manned platforms fighting alongside unmanned systems,” says program manager Lt. Col. Dan Javorsek.

Under the four-year, three-phase program, combat autonomy algorithms and human-machine interfaces will be developed and tested over a series of increasingly complex exercises involving first subscale then full-scale aircraft in 1v1 and 2v2 air combat. “We envision a future in which AI handles the split-second maneuvering during within-visual-range dogfights, keeping pilots safer ... as they orchestrate large numbers of unmanned systems,” says Javorsek.

By training AI in the rules of aerial dogfighting similar to how fighter pilots are taught, ACE may have a key role to play in accelerating the movement of machine learning from the data center into the aircraft cockpits of the future. ©
Michael Bruno  Washington

The Trump administration’s Federal Communications Commission (FCC) is looking to streamline licensing and regulation of small satellites to help catalyze their development and that of related services.

FCC Chairman Ajit Pai told a U.S. Chamber of Commerce event in July that, in essence, smaller satellites—those with mass under 400 kg (880 lb.)—deserve a less onerous process compared with their large, legacy brethren. Commissioners will formally consider a proposed, streamlined framework Aug. 1.

Pai said, in a prepared speech, that if satellite operators want to launch satellites with certain characteristics such as short orbital lifetimes they should not be forced to navigate the longer and more expensive approval processes required for larger-scale missions. “I see no reason why a satellite the size of a shoebox, with the life expectancy of a guinea pig, should be regulated the same way as a spacecraft the size of a school bus that will stay in orbit for centuries,” he says.

The FCC’s deregulatory moves are just the latest evidence of how Washington is warming to the potential that smallsats could bring in both capability and cost. “We now stand on the cusp of unprecedented opportunity for the commercial space sector—and ultimately for American consumers, who will be the chief beneficiaries if the industry can succeed in space,” Pai says.

The Pentagon agrees. In recent remarks to a Brookings Institution event, U.S. Air Force Gen. Paul Selva, the vice chairman of the Joint Chiefs of Staff, offered optimistic comments about whether broadly distributed low-Earth-orbit constellations can provide broadband internet on a global scale. He admitted the idea is old—people imagined it in the late 1990s, when it was still too expensive to put a satellite into orbit and ground-based fiber killed satellite constellations such as Iridium. But the economics may now be changing.

“We may be approaching a break point in the cost of the technologies that says a proliferated low-Earth-orbiting constellation of broadband internet satellites will be much more useful than a web of fiber that circles the Earth,” he says. “I’m not suggesting... that’s an absolute, but when you get to that break point, you’re in a different business model.”

Smallsats are ideal for quick experimentation, such as with Alba Orbital’s Unicorn-1 in partnership with the European Space Agency.

The global smallsat market is projected to grow from $2.18 billion this year to $23.6 billion by 2029, at a compound annual growth rate of almost 27%, according to a new study by Visiongain. The U.S. and other longtime space players are exploring the use of smallsats to meet budgetary constraints among other reasons, and the same drivers are pushing new participants toward the smaller birds, too. “Various emerging countries across the world are looking to develop a space-based capability, within a limited budget and are doing so by investing in the development, manufacturing and launch of small spacecraft,” Visiongain analysts say. “Additionally, the miniaturization of electronics in the commercial sector has encouraged the development of smaller satellites, thereby enabling them to emerge as a crucial platform in a renewed global space race.”

In 2012-18, more than 1,300 smallsats were launched globally. Euroconsult predicts that more than 3,600 will be launched in the next decade, and the number could surpass 10,000 if just some of the planned broadband con-
Stations are deployed, according to the Institute for Defense Analyses. The growth comes as more sectors find more uses for—and increased affordability of—space-based capabilities. “The rapid increase in technological capability and declining cost, through standardized parts and production processes, have made smallsats increasingly useful,” notes the U.S. Chamber of Commerce in a July blog post. More satellites can be deployed in low Earth orbit, allowing for greater coverage.

For instance, if a port operator wanted to continuously monitor the number of containers entering and exiting its facility, it could track that information with a network of small satellites—a capability that would have been “prohibitively” expensive 20 years ago, the business group says. Smallsats also are addressing a range of remote-sensing challenges, from tracking aircraft to providing low-latency communications.

“Whether they realize it or not, every U.S. business is already deeply reliant on space systems today,” the business group notes. “Smallsats have already become indispensable to American [companies], but the nascent smallsat industry is also a growth engine for the U.S. Like other disruptive technologies such as the smartphone or personal computer, the development of smallsats was pioneered in the U.S.”

To date, more than 80% of smallsats have been manufactured by U.S. companies, according to Bryce Space and Technology. But global production is increasing quickly, and the U.S. advantage should not be presumed. “American intellectual property must be guarded carefully or smallsat production will shift overseas and our advantages will wane,” the business lobby group says.

Hence, the FCC’s deregulatory effort. The regulatory review is the first since 2004 for the commercial space sector, says Pai.

According to the draft proposal, the FCC wants to create an alternative, optional application process within Part 25 of the commission’s rules for smallsats. The process could be used by applicants for satellites and satellite systems meeting certain qualifying characteristics such as:

- Ten or fewer satellites under a single authorization
- Total in-orbit lifetime of satellite(s) of six years or less
- Maximum individual satellite wet mass of 180 kg
- Propulsion capabilities or deployment below 600 km (370 mi.) altitude
- Ability to share use of authorized frequency band with current operations and without materially constraining future satellite entrants seeking to use the band
- Relatively low risk from an orbital debris perspective, as assessed through additional clearly ascertainable characteristics.

Pai says the alternative regimen would feature an easier application process, a lower application fee of $30,000, and a shorter review timeline. It would further offer potential radio-frequency interference protection for critical communication links. Lastly, it would promote orbital debris mitigation and efficient use of spectrum. Pai says commissioners could vote on it as soon as the Aug. 1 meeting.
INTEGRATING SPACEPORTS

FAA ISSUES OPERATOR LICENSES FOR 12 SPACEPORTS
CAMDEN COUNTY, GEORGIA, APPLICATION IS PENDING
CONSENSUS LACKING ON SPACEPORT CATEGORIZATION

Bill Carey Washington

There are now a dozen FAA-licensed commercial spaceport sites in the U.S. and more being contemplated. Still under development is a regulatory framework for how they fit into a national airspace system (NAS) structured on airports, air traffic control facilities and navigation aids.

In December 2017, the FAA created a Spaceport Categorization Aviation Rulemaking Committee (ARC), consisting of representatives of the aviation and space communities, to review a draft spaceport categorization scheme and provide “consensus comments and recommendations” on the overall framework.

“Co-location at airports, impacts to air traffic and general public safety considerations are all emergent issues as the commercial space transportation industry becomes more widespread and normalized,” the ARC charter states.

“Spaceport categorization has been proposed as a simple framework to provide clearer expectations, based on concepts of operation, to prospective spaceport enterprises, nearby aviation infrastructure and the FAA,” the charter adds. “The categories are meant to clearly highlight the types of vehicle operations that will be considered at a potential spaceport.”

In the FAA Reauthorization Act of 2018 that became law last October, Congress directed the Transportation Department to establish an Office of Spaceports within the FAA Office of Commercial Space Transportation (AST). Among its functions, the spaceports office should support licensing activities of space launch and reentry sites, develop policies to promote infrastructure improvements and provide spaceports with technical guidance, the act states.

Last November, Transportation Secretary Elaine Chao appointed Wayne Monteith, a former brigadier general who commanded the U.S. Air Force’s 45th Space Wing at Patrick AFB, Florida, as the FAA’s new associate administrator for commercial space transportation, effective Jan. 20. Monteith appointed Ravi Chaudhary, a former Air Force Boeing C-17 pilot and the AST’s director of advanced programs and innovation, to serve as acting director of the Office of Spaceports.

The Spaceport Categorization ARC submitted its report to the FAA this spring. While the agency sought industry consensus on a categorization scheme comparable to the one it uses for the 3,321 public-use airports identified in its National Plan of Integrated Airport Systems, that was not the guidance the ARC delivered.

According to Monteith, “One of the first conclusions they reached is that a spaceport categorization was probably too narrow and would not answer the question we were asking, which was how do you effectively designate a capability at a spaceport so that their neighbors understand what they’re doing?”

What the ARC has recommended is that “rather than a categorization [scheme], an extensive data repository” be established to describe a spaceport’s capabilities and factors such as its distance from major airports and population centers, “and make at least portions of that publicly available,” Monteith says.

Within the ARC, representatives of the aviation industry preferred that spaceports have a launch provider attached to
them, whereas representatives of the space industry favored association with a notional launch vehicle rather than a specific provider, he says.

The FAA is assessing the ARC’s recommendations and has not released its final report. Monteith says the aviation and space communities conveyed their own sets of recommendations. “Much like a Venn diagram, what we’re focused on are the ones where they agree, where they overlap,” he says, adding that both communities agreed on the value of a data repository. The agency also can revisit categorization or create another ARC, he says.

Offering a space industry perspective generally, Eric Stallmer, president of the Commercial Spaceflight Federation, says the aviation industry and airlines “don’t fully understand what the missions are and the goals are for these spaceports.”

While there are currently a handful of operational launch vehicle types, there are numerous others in development, notes Stallmer, who questions whether there is enough launch capacity to meet planned low Earth orbit (LEO), geosynchronous orbit and LEO small satellite constellations (see page 57).

The FAA’s 2018 Compendium of Commercial Space Transportation lists six expendable launch vehicle types available for commercial use in the U.S. and nine orbital launch vehicles in development. There were three suborbital sounding rocket systems and five suborbital reusable vehicles. The agency has granted spaceport operating licenses for orbital, suborbital and combined orbital/suborbital launches.

Some spaceports will be more like technology centers of excellence or development hubs that use their infrastructure for space-related purposes but not necessarily for launches, Stallmer says. “Not all spaceports are the same. Each of these has different missions, and often they get painted into the same box on capabilities,” he says. “There are spaceports out there that will never launch a vehicle but could be very successful in the space industry. It’s more of a total ecosystem.”

The AST has issued 12 commercial launch site operator licenses under its Part 420 regulation, representing half of the 24 commercial, federal government, university and private launch sites in the U.S. A handful of the state-supported commercial sites are the most active, led by Space Florida; Mid-Atlantic Regional Spaceport, Virginia; Pacific Spaceport Complex, Alaska; and Mojave Air and Space Port, California.

Proponents of Spaceport Camden, planned in Camden County, Georgia, on the Atlantic Coast, submitted an application to establish a vertical launch site in early July, starting a 180-day review period during which the FAA evaluates the proposal and either grants or denies a license. The agency has informed the county that it expects to decide by mid-December. Other commercial spaceports are being contemplated in Arizona, Michigan, Hawaii and Alaska, the FAA says.

The Colorado Air and Space Port, awarded a site operator license from the FAA in April 2018, often is mentioned in discussions about spaceport integration due to its proximity to Denver International Airport (DEN). Located at the former Front Range Airport (FTG) in Watkins, Colorado, it lies 6 mi. southeast of DEN, one of the FAA’s Core 30 airports in major metropolitan areas with high traffic volume.

“Space launch operations that are adjacent to airports or overfly land pose a safety risk to the public as well as to commercial aviation,” the Air Line Pilots Association (ALPA) states in a June 2018 white paper that features an illustration of the Denver area and the spaceport facility.

“Spaceports co-located with airports would need to overcome many operational issues such as hazardous fueling, noise abatement, traffic volume/capacity and controller workload,” ALPA says. “Sharing the NAS in this environment would add a level of complexity that we do not have the ability to manage within the current system.”

The FAA’s Denver Terminal Radar Approach Control facility has management oversight of the tower at FTG, which at 190 ft. cab height is the tallest general aviation air traffic control tower in the U.S., according to Adams County, the spaceport developer. For instrument flights, they say, “FTG runways are treated as if they were an extension of DEN runways.” There also is a “cutout” in DEN’s Class B airspace that allows visual flight rules traffic to depart FTG to the east and south without entering Class B restricted airspace.

Adams County and PD AeroSpace of Nagoya, Japan, signed a letter of intent on April 19 to jointly study the use
of the spaceport for the latter company’s Pegasus suborbital spaceplane with a jet/rocket dual-mode pulse detonation engine, designed for horizontal takeoffs and landings. Launch vehicle operators must be separately licensed by the FAA.

While acknowledging “a hue and cry” from the aviation industry to reduce airspace disruptions caused by space launch and reentry activities, Monteith argues that the impact of commercial space is still decidedly small from an air traffic control perspective.

According to data compiled by the FAA Air Traffic Organization’s Systems Operations Analysis Branch, airlines flew 155 million mi. in excess of direct routes, affecting 7 million flights, from Jan. 1-Aug. 31, 2018, due to weather, airspace congestion, airspace restrictions and civil and commercial space launch activity. Space activities alone accounted for 70,000 excess miles, affecting 1,400 flights.

The impact of civil and commercial space activities on excess miles flown during the measured period was 0.05%. The impact in terms of number of flights was 0.02%. “I would suggest to you that even if the space transportation launch rate doubles, it still may not be as disruptive as people perceive,” says Monteith.

Speaking with reporters during a Space Investment Summit his department hosted in December, Commerce Secretary Wilbur Ross expressed concern that states are pursuing too many spaceports. He cautioned against a “vogueish” trend in state and local economic development efforts favoring such facilities.

While the FAA is not studying spaceport capacity specifically, the agency is collaborating with NASA and the Commerce and Defense departments to produce a report on national spaceports policy by October, as directed by Congress in the 2018 reauthorization act. The report should propose “policies and programs designed to ensure a robust and resilient orbital and suborbital spaceport infrastructure” and recommend how the federal government can facilitate greater investment in spaceport infrastructure, the act states.

The legislation directs the Government Accountability Office to study potential mechanisms to provide federal funding support to spaceports, including use of the Airport Improvement Program the FAA administers to issue grants to public-use airports for capital improvements.

Congress authorized the Transportation Department to make space transportation infrastructure matching grants in 1994 legislation. Although the funding vehicle exists, there is no current demand for such grants from the space community, Monteith says.

The FAA’s role is to ensure that space launch and reentry activities are conducted safely, not to choose which states participate in the market, Monteith says.

“It would be disingenuous of me as a regulator to say there are a finite number of spaceports we should have,” he says. “When you take the long view, it is easy to foresee a day when you have point-to-point suborbital transportation. Right now, I can’t tell you what that will look like decades from now, but I wouldn’t want to be the one who picks the state that doesn’t get an opportunity. Our role is to evaluate licenses and not evaluate their business case.”

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The development of Thales’ PureFlyt “extended” flight management system (FMS) marks an early step in the gradual introduction of the connected cockpit concept, where the crew will be able to use data from the “open world.”

Added to data originating from onboard systems, air traffic control (ATC) and an airline’s operations center (AOC), open-world data will typically come from the internet. It is expected to give pilots the benefit of more interactive sources for weather and traffic—among a myriad of possibilities.

Once widespread, connected cockpits will help create the “internet of aircraft,” as Thales’ senior executives characterize it. Experience with smartphone apps shows the industry may be at the beginning of a limitless development of uses. Such an opening is believed to be compatible with aviation’s safety and security standards. Thales engineers are starting with linking the electronic flight bag (EFB) to the FMS for easier flight plan changes.

Honeywell’s FMS Datalink Service has been offered as a way to update weather information inflight. However, the information travels via a company data center. In addition to being limited to weather, the service is less flexible, and probably more expensive, than what Thales hopes to put on the market. Honeywell is also working on crowdsourcing weather data through inflight connectivity.

Meanwhile, GE Aviation and Avionica hope to receive an FAA supplemental type certificate for a connection between GE’s FMS and EFBs next year. If the FMS receives a flight plan update from the AOC or ATC, the crew can transfer it to the EFB and manipulate routes using a graphic interface. A route change can also be sent to the FMS from the EFB.

As EFBs grow more useful, GE sees them becoming integral to the industry’s push to drive operational improvements through real-time data.

Thales has an even more optimistic vision. “More connections between aircraft and other players in the system—such as ATC and AOCs—can only boost the sharing of information when a disruption, such as fog, happens,” says Christophe Picco, Thales’ head of marketing for connectivity.

In Thales’ PureFlyt extended FMS, updating a flight plan is the first function made available to crews. The pilot simulates the change on an EFB tablet. Then the pilot contacts ATC via voice communications or data link, requesting approval. If ATC green lights the modification, the crewmember will send the new flight plan to the FMS from the wired tablet.

Thales engineers are already considering the next step, when the simulated change will be automatically pre-checked with ATC. Such an exchange will involve more data transmission via satellite—a relatively expensive channel. The benefit will outweigh the cost, the engineers say.

Engineers at Thales believe they have mastered the required cybersecurity. The FMS prompts the pilot to authorize every connection, indicating its origin. “We have known the notion of critical software for a long time. . . Cybersecurity naturally infuses into our products,” says Picco, noting that the entire chain—including the aircraft, airport, ATC and airline—should be secured. Moreover, PureFlyt makes sure the flightpath avoids terrain and corresponds to the aircraft’s performance.

In the future, information from weather radar will be merged with open-world weather updates. PureFlyt will also factor in traffic, Thales engineers promise. Development is “practically complete,” and the new FMS could be in service in 2022. The prototype has been part of Thales Airbus A350 flight-deck test bench in Bordeaux, France. PureFlyt could find an application in a new aircraft or as a retrofit, says Guillaume Lapeyronnie, Thales’ cockpit marketing manager.

As for the communications link, the company recommends Inmarsat’s SwiftBroadband and Iridium’s Certus. However, the cost of 1 Mb transmitted for cockpit applications is estimated to be 100 times higher than for passenger connectivity. The International Civil Aviation Organization rules out the use of K_u and K_a bands for aircraft control-domain applications because they are too sensitive to weather, thus only allowing the use of the L band, Picco notes. But the L band’s narrower bandwidth and the services’ high cost has crewmembers looking for a workaround. Some connect to the passenger cabin’s connection, which typically uses the K_q or K_a band.

This option is theoretically prohibited. Thales executives suggest it may be authorized in the future for flight preparation, provided a sufficient level of cybersecurity is demonstrated.

NEW FMS TO HELP WITH FLIGHT PLAN, AND WEATHER UPDATES
AVIONICS-MAKER ENSURES CYBERSECURITY
Honeywell FBWs Key to UK eVTOL Startup

> SECOND PROTOTYPE FLYING IN SECRET IN WALES
> HONEYWELL FBW WILL FLY IN 2020 PROTOTYPE

Graham Warwick Washington

Honeywell’s compact, high-reliability fly-by-wire (FBW) flight control system will be integrated into an electric vertical-takeoff-and-landing (eVTOL) flying prototype in 2020 under a strategic partnership with UK startup Vertical Aerospace.

Bristol, England-based Vertical sees the agreement with Honeywell as a key step toward certification of its battery-powered eVTOL air taxi. The company is aiming for certification late in 2022 and entry into service in 2023. The aircraft will be piloted initially.

Vertical filed in 2018 for European certification under a combination of CS-23 rules for aircraft and CS-27 for helicopters. The European Aviation Safety Agency has since released its Special Condition for VTOL aircraft, which requires commercial-aircraft safety levels for urban air mobility (UAM) operations.

About the size of a hardcover book, Honeywell’s flight-control computer is based on the same design principles as the company’s air transport fly-by-wire systems. The system supports a triplex-redundant system architecture. In addition, each computer uses lockstep processing—two computing channels that constantly cross-check each other. The compact FBW is designed for eVTOL and Part 23/CS-23 aircraft.

Vertical says it is the first eVTOL developer to confirm a partnership with Honeywell on FBW. The U.S. avionics manufacturer has also signed a memorandum of understanding with Pipistrel and Jaunt Air Mobility. These cover avionics, navigation and other systems as well as FBW. Honeywell has also signed an agreement with Volocopter on navigation and automatic landing systems for its eVTOL.

Founded in 2016, Vertical Aerospace flew its unmanned proof-of-concept (PoC) aircraft in June 2018 at Kemble, England. This vehicle had four ducted fans. A second full-scale prototype of a different design is now undergoing ununmanned flight-testing in secret at Llanbedr in North Wales, says Michael Darcy, chief commercial officer.

The PoC aircraft was built using off-the-shelf hardware “to learn about system integration and flying,” he says. The second prototype, to be unveiled in September, “is a more complex vehicle.” The next prototype, to fly in 2020, will be different again, with increased redundancy. “We are not sticking with ducted fans,” says Darcy. “They are good for noise, but not forward flight.”

Vertical is backed by founder and investor Stephen Fitzpatrick, founder and chief executive of UK power supplier OVO Energy. In February, Japan’s Mitsubishi Corp. purchased a 20% stake in OVO, the UK’s largest private energy supplier, for £200 million ($250 million). The company plans to seek outside funding, and a strategic investor for manufacturing, later in the program.

Fitzpatrick previously owned a Formula One racing team, and Vertical is bringing a mix of motorsport and aerospace thinking to development of its eVTOL, says Michael Cervenka, chief operating officer. Cervenka was previously with Rolls-Royce, where he led eVTOL work including development of the Aston Martin Volante Vision concept vehicle. Darcy was previously with Airbus.

The agreement with Honeywell is initially on flight-control system hardware, but Vertical is looking at the potential for broader cooperation, Cervenka says. Partnering with Honeywell is about differentiating Vertical from other startups in the eVTOL market, he adds.

Vertical’s development approach includes flying a number of small models to rapidly iterate the design and begin developing the flight-control laws. A one-third-scale model of the planned aircraft will be tested in a wind tunnel at Airbus in Filton, near Bristol, later this year.

The startup is looking beyond the aircraft, and in February announced it is collaborating with engineering consultancy Atkins to help develop intercity air taxi services. Atkins, part of the SNC-Lavalin Group, is providing Vertical with safety and certification support, and the companies plan to develop a blueprint for UAM covering infrastructure, passenger experience, operating models and cybersecurity.
Request information directly from the manufacturers and suppliers serving the MRO market.

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Recovering Readiness

By Kenneth Watson

Over the past several years, I and many in industry have focused on improving the availability of critical military platforms. We are starting to move the needle in the right direction. But having seen how industry is able to ensure high levels of system availability, I am convinced that the Defense Department can draw on industry best practices to advance its readiness recovery.

We must accelerate our pace: The threats and requirements specified in the National Defense Strategy (NDS) demand better solutions at scale, as well as a consistent urgency of response. The challenging environment we know all too well (federal budget uncertainty, protracted contracting timelines, emergent requirements) simply cannot persist as an alibi. Our nation is counting on us to lead and structure a balanced, vibrant and secure defense industrial base that delivers and sustains a more lethal U.S. military than the one we inherited.

Our major readiness recovery initiatives are improving the mission and field-level materiel availability of key assets. This focus reflects sound strategic prioritization and continues to expand. It also highlights where we need industry’s heightened interest and involvement.

The Pentagon’s unrivaled strength in delivering materiel availability—and where we take great pride in both the legacy and currency of our capabilities—is at the operational or field level. This is where our soldiers, sailors, airmen, Marines and Coast Guard personnel strive for and attain the direct mission results tied to their sustainment efforts. Time and time again they have proven, and we continue to help resource and enable, remarkable sustainment responsiveness and agility. Given well-defined accountability for sustainment outcomes at this level, focusing our initial readiness recovery on the field makes good sense.

Accountability for sustainment outcomes and mission focus is not nearly as clear in our wholesale-level—or, in the case of maintenance, our depot-level—maintenance, repair and overhaul organizations and operations. This is where Pentagon readiness recovery could benefit from industry’s perspective on implementable concepts, metrics and management frameworks. In this wholesale terrain, there is no enterprise-level approach guiding this large, complex and multilayered public and private enterprise toward common outcomes, nor to drive the ownership and accountability required to obtain them.

If the department does not improve alignment and accountability throughout its wholesale support functions (to include its industry providers), enduring weapon-system readiness recovery will not occur, and our combined industrial base will not meet NDS requirements. Increased industry attention and consideration in these three areas would help generate required momentum:

■ Collaborative Business Arrangements The quality and nature of our collaborative business relationships in the wholesale space must shift to better support materiel availability outcomes. Incentive structures must be clear, reasonable and sensitive to cost pressures. The current Pentagon management framework must align toward a more integrated enterprise—one that recognizes strengths, weaknesses and critical capabilities of both sectors. Novel or well-established commercial operational tenets, frameworks and collaborative mechanisms are needed to align incentives and capabilities.

■ Commercial Derivative Metrics The Defense Department has operationalized materiel health metrics and is improving data-driven decision-making as well as the asset visibility required to deliver weapon-system availability at best cost. Commercial derivative metrics could further assist the Pentagon with individual fleet and enterprise-wide metrics that identify and drive readiness recovery opportunities. Examples of proven, well-aligned metrics structures are needed to increase the effectiveness and efficiency of aspects of the department’s wholesale system.

■ Enterprise Management and Accountability Our industry partners, particularly those who have closely supported the Defense Department, know our unique mission, resource challenges and demanding operational environment—as well as the fact that much of our lethality is generated from legacy weapon systems. We need a fresh look at our wholesale organizational structure with an eye on the span of control, authority, accountability and responsibility. We need to better understand how the department and industry can shape a wholesale enterprise that minimizes unnecessary duplication of systems, facilities and production capabilities while delivering challenging NDS-driven outcomes.

Consider these three areas as catalysts to help confront the status quo and apply to our wholesale industrial base the energy, ingenuity and resourcefulness we see in U.S. “boots on the ground.” Our connection to them must improve—and it is nothing less than a sacred bond.

Kenneth Watson is the deputy assistant secretary of defense for materiel readiness.
Recovering Readiness

Kenneth Watson

The Pentagon’s unrivaled strength in delivering materiel readiness recovery on the field makes good sense. For sustainment outcomes at this level, focusing our initial responsiveness and agility. Given well-defined accountability to help resource and enable, remarkable sustainment results.

Time and time again they have proven, and we continue to prove—and it is nothing less than a sacred bond. The energy, ingenuity and resourcefulness we see in U.S. Marines and Coast Guard personnel strive for and attain.

Our major readiness recovery efforts are improving the availability of critical assets. This is at the operational level.avia and currency of our capabilities—is at the operational availability—and where we take great pride in both the legitimacy and overall performance of the department’s wholesale system.

Our nation is counting on us to sustain a more lethal U.S. military than the one we inherited. The Defense Department, know our unique mission, resource management frameworks. In this wholesale terrain, industry can shape a wholesale enterprise that minimizes the direct mission results tied to their sustainment efforts.

Enterprise-wide metrics that go with individual fleet and mission readiness.

Consider these three areas as catalysts to help confront the status quo and apply to our wholesale industrial base:

- Accountability for sustainment outcomes and mission readiness recovery.
- Enterprise Management and Accountability.
- Collaborative Business Arrangements.

■ Enterprise-wide metrics that go with individual fleet and mission readiness.
■ Commercial derivative metrics and is improving data-driven decision-making as incentives and capabilities.
■ Commercial Derivative Metrics

The quality and currency of our capabilities—is at the operational level. Availability feedback, emergent requirements (federal budget uncertain)

The challenging nature of our collaborative business relationships in the complex and multilayered public and private enterprise world. We need a fresh look at our wholesale organizational structure with an eye on the span of response. The challenging environment we know all too well (federal budget uncertain).

Department leadership and structure a balanced, lead and cadre, collaborative, long-term, integrated enterprise—more than the one we inherited. The current incentives and capabilities of both sectors. Novel mechanisms are needed to align weaknesses and critical capabilities of both sectors. Novel mechanisms are needed to align weaknesses and critical capabilities.

The Defense Department has focused on improving the availability of critical assets. This is at the operational level. Time and time again they have proven, and we continue to prove—and it is nothing less than a sacred bond. The energy, ingenuity and resourcefulness we see in U.S. Marines and Coast Guard personnel strive for and attain.

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