NEW CIVIL ROTORS
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A legacy of innovation

Did you know that our legacy of expertise in flight controls encompasses military applications? In addition to being the first to introduce fly-by-wire in a civil aircraft with the A310, we were also the first to integrate fly-by-wire technology on military platforms with the F-16 and F-18 – changing the way the world flies. We’re not new to the idea of changing the game. We’ve been innovating for flight almost as long as man has been flying.
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ON THE COVER
Helicopter manufacturers are tapping new markets and technology developments to rebound from the challenges of recent years. London Bureau Chief Tony Osborne’s report begins on page 48. Airbus Helicopters photo of the new-generation medium twin-turbine H160 by Anthony Pecchi.

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AVIATION WEEK & SPACE TECHNOLOGY

Editor-In-Chief: Joseph C. Anselmo
joe.anselmo@aviationweek.com

Managing Editors
Jen DiMascio (Defense and Space)
jen.dimascio@aviationweek.com
Jens Flottau (Commercial Aviation)
jens.flottau@aviationweek.co.uk
Graham Warwick (Technology)
warwick@aviationweek.com

Associate Managing Editor: Andrea Hollowell

Art Director: Lisa Caputo

Editors
Lindsay Bjorregaard, Michael Bruno, Bill Carey, James Drew, Thierry Dubois, William Garvey, Irene Klotz, Helen Massey-Beresford, Jefferson Morris, Guy Norris, Tony Osborne, Bradley Perrett, James Puazi, Adrian Schofield, Lara Seligman, Lee Ann Shay

Artists
Scott Marshall, Colin Throm

Copy Editors
Dan Hockensmith, Richard Leyshon, Arturo Mora, Patricia Parmalee, Andy Savoie

Production Editor: Bridget Horan

Chief Aircraft Evaluation Editor: Fred George

Contributing Photographer: Joseph Pries

AviationWeek.com

Director, Editorial and Online Production: Michael O. Lavitt

Director, Digital Content Strategy: Rupa Haria

Digital Content Marketing Manager: Regina Kenney

Editorial Offices:
166 Avenue of the Americas, New York, NY 10036
Phone: +1 (212) 204-4200

2121 K Street, NW, Suite 210, Washington, D.C. 20037

Bureaus

Auckland
Bureau Chief: Adrian Schofield
aschofield@gmail.com

Beijing
Bureau Chief: Bradley Perrett
bradley.perrett@aviationweek.co.uk

Cape Canaveral
Bureau Chief: Irene Klotz
irene.klotz@aviationweek.com

Chicago
Bureau Chief: Lee Ann Shay
leean.shay@aviationweek.com

Frankfurt
Bureau Chief: Jens Flottau
jens.flottau@aviationweek.co.uk

Houston
Bureau Chief: Mark Carreau
mark.carreau@gmail.com

Kuala Lumpur
Bureau Chief: Marhalim Abas
marhalim68@gmail.com

London
Bureau Chief: Tony Osborne
tony.osborne@aviationweek.co.uk

Los Angeles
Bureau Chief: Guy Norris
guy.norris@aviationweek.com

Lyons
Bureau Chief: Thierry Dubois
thierry.dubois@aviationweek.com

Moscow
Bureau Chief: Maxim Pyadushkin
m.pyadushkin@gmail.com

New Delhi
Bureau Chief: Jay Menon
jaymenon68@gmail.com

Paris
Bureau Chief: Helen Massey-Beresford
helen.massey-beresford@aviationweek.co.uk

Washington
Bureau Chief: Jen DiMascio
jen.dimascio@aviationweek.com

Wichita
Bureau Chief: Molly McMillin
molly.mcmillin@aviationweek.com

Gregory Hamilton: President, Aviation Week Network

An Informa business

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The SpeedNews’ 6th Annual Aerospace Manufacturing Conference will bring together leading manufacturers and suppliers in the aerospace industry to present updates and developments in manufacturing operations, capabilities and processes, innovation within manufacturing, modern machining technologies, and industry automation. Delegates will also have the opportunity for an exclusive VIP site visit to explore the world-class NASA-owned Michoud Assembly Facility.

**WHY ATTEND**

The Conference will focus on all key manufacturing aspects including: tooling, machining, components, electronics, advanced materials engineering, and technological systems. In addition, it will cover what is really behind the hype of Internet of Things (IoT), Additive Manufacturing (AM) and Big Data and how the Auto and Aero industries learn from each other.

Delegates will be updated with real examples of products and knowledge that will help and inspire them to improve productivity and profitability for their own operations.

**WHO SHOULD ATTEND**

- C-level Executives, Presidents and GMs
- Directors and VPs of Product Manufacturing
- Production, Operational and Quality Control Professionals
- Aerospace Engineers and Managers
- Procurement and Supply Chain Professionals
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CIVILITY AS A CORNERSTONE
I am disappointed in the level of discourse and maturity displayed in many of the recent comments regarding nuclear weapons policy (Feb. 12-25, p. 6). Reader Thomas Trinko asserts, “It is clear that the authors are more interested in scoring points against Trump than with actually reducing the risk of nuclear war.” Reader J. Richard Snow proclaims, “The UCS is a left-wing organization.” Online, reader Totem101 chimes in with: “The liberal voices here seem to want us to unilaterally disarm.”

Like Mr. Snow, I, too, am astonished. But mine stems from such a quality science-based publication as Aviation Week & Space Technology running such puerile commentary. The aim of the discussion is to construct a viable, lasting and robust national nuclear policy. While politics are inevitably intertwined, insulting and name-calling those with whom you disagree contributes nothing and is the antithesis of a reasoned constructive debate.

While we all likely agree on the desired outcome, there will be many opinions and beliefs on how to accomplish that, as well as multiple ways to get there. But we cannot do them all, so the process to select one from among the best involves exploring them all. Doing so is not the pursuit of a Republican or Democrat, right or left-leaning, or conservative or liberal bias, but rather simply a wise and prudent delving into options.

We are all patriots. Respect those with whom you disagree, and they will in turn grant that same respect back to you.

Don Burkhart, Kirkland, Washington

FLEXIBLE FACTORING?
Qantas CEO Alan Joyce is quoted in First Take (Feb. 12-25, p. 12) saying two Boeing 787s—from Sydney to London—burn 5% less fuel than a single Airbus A380.

Hmmm, does the 5% fuel saving cover the cost of two times the flight crew plus additional cabin crew? And how do aircraft purchase/lease costs affect the equation? Has he factored in an added costly London arrival slot? Too many variables make his assertion hard to sustain.

D.P. Macleod, Glen Burnie, Maryland

The STS-107 Columbia crew

“HUMAN SPACEFLIGHT PROGRAMS . . . HAVE TRIED TO MAKE THE LOC NUMBER ‘GO AWAY’ WHEN THEY CAN’T MEET IT.”

— TOM MEGNA
commenting about ‘What’s in a Number’ (Jan. 29-Feb. 11, p. 18)

QUESTIONING THE PATH
In her Launchpad commentary “What’s in a Number” (Jan. 29-Feb. 11, p. 18), Irene Klotz writes that just because the new SpaceX and Boeing crew vehicles do not meet the loss-of-crew (LOC) requirements doesn’t mean that they are not safe. The LOC metric should not be treated in such a cavalier fashion.

The LOC analyses show that micro-meteoroid and orbital debris (MMOD) at the International Space Station is the largest contributor to the LOC for the mission. Knowing this, why haven’t NASA or the contractors taken positive action to help mitigate the risk? MMOD and launch escape factors contributing to LOC have been well-known for the past 20+ years. These are not recent revelations. Usually, launch escape systems have some reduced fault tolerance since a vehicle failure must happen first, resulting in the need to escape. However, the poor reliability of the escape system does result in a contribution to LOC.

What is happening now is that it is time to once again soften the approach to meeting LOC and rationalize the requirement into a design goal. Human spaceflight programs since the shuttle have all grappled with this issue and all have tried to make the LOC number “go away” when they can’t meet it. It seems that these new programs are following the same path.

Tom Megna, Littleton, Colorado

WAXING AND WANING WAGES
Henry Canaday in “MAX Versus Neo” (Feb. 12-25, p. MB022) writes that “U.S. mechanics’ wages increased 7-12% from 1999 to 2016 after adjustment for general inflation.”

Well, I know what I received in wages from my job starting in August 1998 through September 2016. It was accrued working at the same major U.S. airline. Note that I am exactly 3% behind inflation using the government inflation calculator (data.bls.gov).

I therefore question the accuracy of his numbers.

Havah Gordon, Tulsa, Oklahoma

(The numbers cited in the article were taken from the Bureau of Labor Statistics and encompass average wages for both airline and non-airline mechanics. Results for airlines only or for a specific airline may differ—Ed.)

ANGELS’ UNHERALDED NEW RIDE
I am somewhat surprised you have not written anything about the Blue Angels flying Super Hornets during winter practice and the current air show season.

I guess that with all the press on the poor shape of naval aircraft, the brass did not want to highlight the loss of fleet Super Hornets to their flying team. Their silence may be more newsworthy than the model change itself.

Dave Collier, Stuart, Florida

Address letters to the Executive Editor, Aviation Week & Space Technology, 2121 K Street, NW, Suite 210, Washington, DC, 20037 or send via email to: awstletters@aviationweek.com. Letters may be edited for length and clarity; a verifiable address and daytime telephone number are required.
To many variables make his assertion hard to sustain. How do aircraft purchase/lease costs affect the equation? Has he factored in how much additional cabin crew? And what about fuel? Airbus A380 don’t burn 5% less fuel than a single-aisle aircraft. Qantas CEO Alan Joyce is quoted in saying two pathways to FLEXIBLE FACTORING?

Don Burkhart, Kirkland, Washington

In her Launchpad commentary, Irene Klotz writes that just questioning the path of-crew (LOC) requirements doesn’t make them reasonable or credible. The LOC analyses show that micro-meteoroid and orbital debris (MMOD) is the largest contributor to the LOC number, yet the authors are more interested in scoring points against Trump than with actually reducing costs and risks associated with the LOC. Reader J. Trump than with actually reducing costs and risks associated with the LOC.

Like Mr. Snow, I, too, am astonished. It is clear that the authors are more than the model and the model stems from such a quality of a Republican or Democrat, right or left-leaning, or conservative or liberal voices here seem to want us to conclude that spaceflight is a science-based publication as well. The UCS is a left-wing organization. Online, Richard Snow proclaims, “The UCS is an anti-nuclear group that doesn’t care about the risk of nuclear war.” Reader J. Trump than with actually reducing costs and risks associated with the LOC.

I am somewhat surprised you have written nothing about the Blue Angels flying team. Their silence may be saying two things: “You can’t meet it.” The LOC requirement into a design goal. Human reliability of the escape system does not mean that they are not safe. The LOC analyses show that micro-meteoroid and orbital debris (MMOD) is the largest contributor to the LOC number, yet the authors are more interested in scoring points against Trump than with actually reducing costs and risks associated with the LOC. Reader J. Trump than with actually reducing costs and risks associated with the LOC.

While we all likely agree on the importance of protecting our planet and the need to transition to renewable energy sources, there are differing opinions and beliefs on how to accomplish that, as well as multiple ways to approach it. It’s a complex issue that requires reasoned, constructive debate. The aim of the Aviation Week & Space Technology is to construct a viable, lasting and robust national nuclear policy. While politics are inevitably intertwined, insulting and name-calling policy. The UCS is a left-wing organization. Online, Richard Snow proclaims, “The UCS is an anti-nuclear group that doesn’t care about the risk of nuclear war.” Reader J. Trump than with actually reducing costs and risks associated with the LOC.

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Letters may be edited for length and clarity; awstletters@aviationweek.com

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James Reilly, a former astronaut and veteran of five spacewalks, has been named director of the U.S. Geological Survey. Reilly has been a technical advisor to the U.S. Air Force National Security Space Institute. Prior to NASA, he was chief geologist at Enrich Exploration Inc.

Airbus has appointed Bruno Even CEO of Airbus Helicopters. He was CEO of Safran Helicopter Engines and succeeds Guillaume Faury, who will become president of Airbus Commercial Aircraft.

Safran Group has named Vincent Mascre board chairman of Zodiac Aerospace and CEO of its seats business. Jean-Paul Alary succeeds Mascre as CEO of Safran Landing Systems. Following Alary is Cedric Goubet, who has been appointed CEO of Safran Nacelles and to the board.

Liquid Measurement Systems Inc. has promoted Mark Connors to chief technology officer from engineering manager. Connors previously held positions at UTC Aerospace, General Dynamics, Pratt & Whitney and as a U.S. Air Force flight test engineer.

Michael D. Ruppert has been promoted to Mercury Systems Inc. chief financial officer and treasurer from executive vice president of strategy and corporate development.

Hitoshi Moriguchi has been promoted to vice president of production for Quest Aircraft. He will remain executive vice president and a board member for the Kodiak manufacturer.

Raytheon Co. has promoted Kelsey DeBryin to vice president of investor relations from senior director. She had been a BlackRock aerospace and defense equity research analyst and before that an analyst at Goldman Sachs.

Sam Mehta has joined Gresham, Smith and Partners as senior vice president in the water and environment practice. He had been environmental manager at San Francisco International Airport.

UPS has appointed Christiana Smith Shi company director. She is founder and principal of Lovejoy Advisors and former president of Nike’s direct-to-consumer business.

Lee Brewster has joined Flightdocs as director of customer solutions. She was most recently product sales manager for FlightSafety International’s maintenance training programs.

Rob Abbott has been appointed Cranfield University director of aviation operations, overseeing the school’s National Flying Laboratory Center, the Cranfield Airport and installation of a digital control tower. Abbott had been commercial aviation director at Aviellant Ltd.

U.S. Army Lt. Gen. (ret.) David F. Melcher has been named to the Cubic Corp. board of directors. He had been president/CEO of the Aerospace Industries Association.

Akin Gump has appointed Mark A. Aitken II as a senior policy advisor in its communications practice. Aitken had been director of government relations at the Association for Unmanned Vehicle Systems International.

Polaris Alpha has named Kenneth (Steve) Callicutt to its board of advisors. Callicutt is a former U.S. Strategic Command director.

CPI Aerostructures has hired Jay Mulhall as senior director of business development and strategy for defense markets. He had been senior director of business development for military aircraft systems at Northrop Grumman.

Ansgar Lubbehusen has been promoted to head of Lufthansa Systems marketing and communications from press spokesman and head of corporate communications.

MEI Technologies Inc. has named Stephanie Murphy executive chairman of the board. She succeeds founder Edelmiro Muniz, her father, who will remain an advisor.

Duncan Aviation has hired Mike Dunham as a sales representative for turbine engine services. Most recently, he was a sales representative for Vector Aerospace, focusing on Pratt & Whitney Canada PT6, JT15D and PW100 engines.

Don West has been promoted to avionics sales account manager for Western Aircraft from avionics team lead. In addition, Paul Harrington has been hired as an avionics team lead and Jeff Watson has been promoted to turboprop service manager.

Aero Precision Holdings has hired Daniel Boen as DAC International regional sales manager. He had been senior account manager for Matrix Aviation/Professional Aviation Associates. Prior to that, he was with Rockwell Collins.

Reassigned: Robonaut, a prototype humanoid robot developed by NASA in partnership with GM. Joined International Space Station crew in 2011 as astronaut assistant/tech demo. Headed back to Earth for repairs and refurb following troubled 2015 hardware upgrade.

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

Extraordinary together
Boeing’s 737-9 has gained FAA certification, clearing the way for the second MAX variant to enter commercial service with launch operator Lion Air of Indonesia.

Pratt & Whitney is reverting to a previous configuration of a PW1100G high-pressure compressor aft hub knife-edge seal to restart production and fix in-service engines affected by issues with a modified design. Airbus expects to resume deliveries of Pratt-powered A320neos in April. It stopped accepting new PW1100Gs on Feb. 10 after a series of inflight shutdowns (page 36).

Airbus delivered the first A350-1000 to Qatar Airways on Feb. 21, introducing several improvements it says will eventually flow down to the smaller A350-900 (page 30).

The heating system for all three pitot tubes was turned off on the Saratov Airlines Antonov An-148 that crashed on Feb. 11, killing all 71 passengers and crew on board, several minutes after taking off from Moscow Domodedovo Airport en route to Orsk, Russia. The heating system had been switched on for the 15 previous flights, says Russia’s Interstate Aviation Committee.

An Iran Aseman Airlines ATR 72-200 crashed about 13,000 ft. up a mountain range in Isfahan Province on Feb. 18, killing all 66 people on board. Flight EP-3704 was en route from Tehran to the southwestern city of Yasuj. Heavy snow hampered recovery efforts.

Boeing’s C Series price-dumping charges against Bombardier failed because the U.S. International Trade Commission could find no evidence the U.S. manufacturer had lost sales or revenue in the two campaigns investigated, at Delta Air Lines and United Airlines. Delta now expects to take delivery of some CS100s this year from Canada, before the U.S. assembly line at Airbus in Mobile, Alabama, is operational, planned for 2019.

Airline industry groups are calling on Congress to end a ban on the FAA regulating small drones flown for recreation, citing airspace safety concerns. The Flight Safety Foundation has called on the International Civil Aviation Organization to expedite global standards for all small drones, including recreational.

Indonesia finally has signed a contract for 11 Sukhoi Su-35s, four years after selecting the Russian fighter to replace its fleet of Northrop F-5s. Indonesia will be the second Su-35 operator in Asia, after China with 24. In July 2017, Russia’s defense minister said the deal for 11 Flankers was worth $1.14 billion.

Airbus took another €1.3 billion ($1.62 billion) in charges associated with the A400M airlifter in 2017 but expects a new agreement with its customers to stabilize the program. “The worst is

NASA’s Astronomy Budget Battle

As astronomers inch closer to grasping the mysteries of dark matter and hidden planets, they are incensed to learn that the Trump administration is cutting off the Wide Field Infrared Survey Telescope (Wirst), seen as one of the key efforts in the U.S. to answer those questions and deepen humanity’s knowledge of the Universe.

NASA’s fiscal 2019 budget request recommends canceling the two-year-old Wirst program, the successor to the James Webb Space Telescope slated for launch in the mid-2020s, and before it, the Hubble Space Telescope. NASA sought to use a 2.4-m (7.87-ft.) optics assembly developed by the National Reconnaissance Office for Wirst, which is to have a resolution equal to Hubble with 100 times the field of view.

“We cannot accept termination of Wirst, which was the highest-priority space-astronomy mission in the most recent decadal survey,” says Megan Donahue, president-elect of the American Astronomical Society. “And the proposed 10% reduction in NASA’s astrophysics budget, amounting to nearly $1 billion over the next five years, will cripple U.S. astronomy.”
clearly behind us and we are over the hump,” says CEO Tom Enders (page 23).

South Africa’s Paramount Group has launched a version of its Mwari multi-mission aircraft for the U.S. market.

The Bronco II, offered by newly created Bronco Combat Systems USA, is aimed at potential requirements such as special operations, border patrol and the U.S. Air Force OA-X program.

UK and U.S. teams have submitted their final proposals to replace Belgium’s F-16 fighters. Feb. 14 was the deadline for the final two candidates—the Eurofighter Typhoon, being offered by Britain, and the Lockheed Martin F-35, offered through the U.S. Foreign Military Sales system—to provide their best bids. A decision is expected this year, with a contract scheduled to be signed in 2019.

The U.S. Air Force is moving forward to quickly begin buying new GPS III navigation satellites that can survive in a contested environment. A request for proposals released on Feb. 13 kicked off the next phase in a competition for 22 GPS satellites for delivery by 2026. Boeing, Lockheed Martin and Northrop Grumman are competing for the November award of an initial contract for development of two satellites.

In a peculiar twist in the U.S. Navy’s MQ-25 Stingray competition, General Atomics Aeronautical Systems has partnered with rival Boeing’s Autonomous Systems division to bid for the carrier-based, aerial-refueling unmanned aircraft (page 22).

First Wichita-Built 737 Fuselage Nears Completion

Forward and rear halves of the eighth Boeing 737 short/medium jet transport are nearing completion at the company’s Wichita, Kansas, facility. The first Wichita-built fuselage will be shipped to Seattle this month, following a shift of the entire fuselage production line from Seattle to Kansas. The move is designed to increase about 100,000 sq. ft. of Seattle for expanded 737 wing assembly.

Defense Upheaval in Canada

A botched effort to fulfill a repeat order for Bell 412 helicopters from the Philippines Air Force has Canada revamping its arms export mechanisms. The $535 million deal for 16 helicopters was announced on Feb. 6. A day later, Ottawa said the sale was under review related to concerns over human rights abuses. On Feb. 9, Philippines President Rodrigo Duterte canceled the order.

Immediately, the Trudeau government announced it would amend legislation to include a clause to bar exports if there is a “substantial risk” of them being used to violate human rights. The head of the Canadian Crown Corp. that brokered the Bell deal was replaced, and Ottawa announced that the government trade corporation will “move away from a concentration in defense.”

The Philippines already operates 10 Canadian-produced Bell 412s, ordered in two batches in 1994 and 2014, but activists opposed the latest sale because of human-rights violations in Duterte’s war on drugs. Duterte said it was unavoidable that the helicopters would be used “against rebels and terrorists.”

It was a busy couple of weeks for Canadian defense, meanwhile. Boeing registered interest in Ottawa’s 85-aircraft fighter competition despite Canada’s canceling plans to buy F/A-18E/Fs because of the manufacturer’s trade dispute with Bombardier. And Canada rejoined NATO’s Airborne Early Warning Force—four years after it withdrew to save money, forcing retirement of two of the alliance’s 17 E-3s.

51 YEARS AGO IN AVIATION WEEK

The completion of the first Boeing 737 fuselage at the company’s Wichita, Kansas, facility was reported on page 47 in our Feb. 13, 1967, edition. Boeing had no room left at its main commercial facility in Renton, Washington—which was busy churning out 707-320s and 727-200s and designing a supersonic transport—so it sent the 737 work to Wichita with a plan to transport the finished units back to Renton in two units via rail. Assembled today in the same facility by Spirit AeroSystems, which acquired the Wichita operation from Boeing in 2005, the 737 fuselages are produced at a rate of 52 per month, with plans to raise the rate to 57 per month in 2019. On Feb. 13, a fuselage for a 737-8 became the 10,000th Wichita-built unit, another milestone for the most-produced commercial jet airliner in history.

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Foreign Military Sales system—to
Martin F­35, offered through the U.S.

fered by Britain, and the Lockheed
the Eurofighter Typhoon, being of­
deadline for the final two candidates—

12

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Wichita, Kansas, facility was reported on page 47 in our Feb. 13, 1967,
VERTICAL INTEGRATION is not a new idea in aerospace. For much of the Jet Age, aircraft OEMs were vertically integrated, but in the 1990s, outsourcing and Tier 1 supply-chain strategies took hold.

After that era of outsourcing, the pendulum once again is swinging in the direction of vertical integration. This is particularly true with Boeing, which is combining insourcing with recruitment of new suppliers and its Partnering for Success program to create greater leverage on suppliers. The question on the suppliers’ minds is: Where could Boeing vertically integrate next? There are several candidate components and systems.

### Going Vertical

**How far could Boeing take insourcing?**

In aerostructures, Boeing added capability in recent years by purchasing several aerostructure facilities, establishing a propulsion center of excellence and building a huge composite wing factory. Where could Boeing go next? It might choose to add complete nacelle and thrust-reverser capability, which have healthy aftermarket revenue streams and will be the core of future high-bypass-ratio aircraft designs. Airbus recently announced it will produce these components for the A320neo. Boeing also could choose to add pylon capability, which is insourced by Airbus as well. Greater fuselage capability is another possibility, although these suppliers usually contribute risk-sharing capital for new aircraft programs.

Boeing abandoned most of its aircraft systems capability years ago but is reversing course. It took on flight-control integration for the 777X and recently added actuator production. The company also reestablished design capability (and aftermarket control) of the 777X’s landing gear after outsourcing it on the 787. Boeing could choose to add flight-control computer capability—a move Airbus made on the A380. As aircraft become more electric, and with future aircraft employing energy-harvesting and hybrid-propulsion concepts, the airframer might decide to play a stronger role in electrical power distribution and auxiliary power as alternative technologies emerge. Air management, although not strategic, has healthy aftermarket content and also could be a target.

Boeing surprised many when it announced an avionics center of excellence last year—a move that may have contributed to UTC’s decision to acquire Rockwell Collins. Boeing has not announced where it will focus its new capabilities, but there are several possibilities.

One is the Common Core System, which includes cabinets that host the aircraft’s avionics and utilities functions as well as the network that allows for the data exchange throughout the system. It acts as the aircraft’s central nervous system, and Boeing’s engineers were heavily involved in its development. Another possibility is in flight management systems, sophisticated computers that manage aircraft flight plans. Developing either of these capabilities would cost hundreds of millions of dollars and add execution risk to future aircraft programs. The company also could expand its role in developing components associated with aircraft health and data management.

Boeing has been active in taking on more cabin work, too. In 2011, it stood up an Interiors Responsibility Center in Charleston, South Carolina, to expand its manufacturing capability, and last month announced a joint venture with automotive interiors giant Adient to produce aircraft seats. Boeing is already one of the largest suppliers of monuments, interior panels, luggage bins and crew-rest compartments. It could go further and expand capabilities in inflight connectivity or other interior systems.

The potential rewards of vertically integrating include higher profitability, greater supply-chain control, reduced development cycle times and enhanced aftermarket revenues as Boeing pursues its $50 billion services goal. These must be balanced against notable risks. Boeing is turning variable costs into fixed costs and whittling away opportunities for risk-sharing partners. This means it will take on greater financial uncertainty in future programs. Another danger is that it could harm innovation and competitiveness if it integrates vertically on the wrong systems. Boeing also could face backlash from customers or regulators if it goes too far. Finally, suppliers could engage in further consolidation, align with Airbus or exit the air transport sector for more profitable opportunities.

In making these vital decisions, Boeing would do well to remember the legacy of Jose Ignacio Lopez, General Motors purchasing chief in the early 1990s, who used brutal tactics to reduce supplier prices and boost profitability. He discarded established norms and the concept of supplier partnership. GM did save a few billion dollars in parts purchases before Lopez ignominiously departed for Volkswagen, but he left its supply chain in tatters. GM competitors that embraced long-term partnership, including Toyota and Ford, fared better in the long run.

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**Contributing columnist Kevin Michaels is president of AeroDynamic Advisory in Ann Arbor, Michigan.**
GOING CONCERNS
MICHAEL BRUNO

Help Wanted

President says more defense dollars and jobs coming—trends disagree

Like other defense primes and major suppliers in aerospace, Lockheed leaders have stressed plans for new hiring, especially after Trump was elected and briefly turned a spotlight on offshoring moves and the prices of major weapons programs like the F-35. But those plans reflected expected growth from ongoing business ventures started in the previous administration and after years of market contraction under sequestration introduced by the 2011 Budget Control Act.

At the same time, industry’s hiring has been tempered by the advent of automation and other digital technologies that allow for fewer, albeit generally more technologically savvy workers. For instance, Boeing cut its staff by at least 6% between 2016 and 2017, or about 9,700 workers altogether, and it is down from a total of around 174,000 in 2012. This came while notching record annual commercial aircraft deliveries, including 763 last year and the 800-815 seen for this year.

Indeed, Lockheed Chief Financial Officer Bruce Tanner told Cowen and Co.’s 39th Annual Aerospace/Defense & Industrials Conference on Feb. 8 that within five years “everything” will change about how the F-35 OEM does business, as well as how the government contracts for aerospace and defense, due to digitization.

“This whole digital transformation that is coming up, it won’t be finished five years from now, but it will be a heck of a lot further along than it is right now,” Tanner said. “It is going to change everything about the way we design our platforms, about how we build those platforms, the way we hire people to design those platforms. It is a revolution—it is not an evolution, it is a revolution coming—that is going to change the way we do business, and frankly, the way the government contracts for this business. I’m not sure everyone fully understands how significant a change it is going to be, but it is going to be massive.”

Meanwhile, the U.S. A&D industry continues to shed workers overall, with more layoffs expected. According to statistics provided last summer by the Aerospace Industries Association, industry employment at the end of 2016 stood at 2.421 million. That compares with 2.435 million for 2015, and the 2012 peak of 2.442 million. Data for 2017 should be released later this year.

Perhaps Trump’s spending surge will lead to growth in A&D employment, but if not, it may not be his fault. Worth a separate discussion is whether it was worth the cost of trying.

AviationWeek.com/awst
COMMENTARY

INSIDE BUSINESS AVIATION

WILLIAM GARVEY

IT IS SILENT COMPARED WITH A LEAP 1B OR EVEN A HOOVER UP-RIGHT, but its sucking power is stronger than either, and that has business aviation worried.

The engine at work is a global shortage of air carrier pilots. Airframe manufacturers have long predicted the shortfall of flight deck personnel now underway that will eventually grow into the hundreds of thousands.

The reasons for that are several: mass retirements of senior pilots; a notable reduction of military transfers as result of the services’ retention efforts; the launch of new carriers and expansion of established airlines; the 1,500-flight-hour requirement for new first officers, which can take years and considerable outlay to achieve; and a general lack of “air-mindedness” on the part of GenXers and Millennials.

In order to fill the front seats of the thousands of Boeing 737 MAXs, Airbus A320neos, Bombardier C Series aircraft and Embraer E-Jets they plan to fly, the airlines are employing a variety of tools including sponsoring ab initio programs, partnering with aviation universities and ending furloughs. But arguably the most effective device is plain old dough—more of it, that is, in the form of bonuses and higher pay.

Needless to say, veteran airmen have noticed the change and are rightly savoring their increased value in the marketplace. And it seems a special target for the airlines’ appeals are the pilots who fly business aircraft. For good reasons.

These are proven, professional aviators, not wannabes. They have demonstrated a career commitment to aviation. Most have logged thousands of hours in multiengine turbine aircraft, many of which have systems equal to or more advanced than those in jetliners. Most have flown in all types of weather conditions and operated into airports shared with the airlines. All are instrument-rated and often fly approaches more challenging than those most frequently used by the airlines. Virtually all those operating jets and many operating turboprops fly as crew, have acquired type ratings and demonstrated their proficiency regularly at simulator training centers. Many have extensive international experience. All understand and are proficient at flight, fuel and weight planning, and weather analysis. Physically fit, they adhere to standard operating procedures and embrace crew resource management. And they all know that the comfort of their passengers is second only to safety.

There’s more. Even though a senior captain on a Gulfstream, Falcon or Global business jet can make a comfortable, six-figure salary, the compensation will almost never equal that of a widebody airline captain flying internationally. However, often more significant than the pay discrepancy is predictability. Airline pilots know well in advance when they will have time off, but business aviation is unpredictable. After all, its go-whenever-wherever nature is the segment’s central appeal. And those providing that kind of flexibility miss a lot of school plays, birthday parties and anniversary dinners.

So an invitation to make more money and get a flight schedule with guaranteed time off definitely appeals to business pilots. But are they accepting? Silly question.

Charlie Priester, chairman of Priester Aviation, a Chicago-based charter and aircraft management firm, says regarding pilot retention, “the whole landscape has changed” since the airlines raised their Come Hither sign. Of the airline shortage’s impact on business aviation’s ranks, he says, “It’s severe, and my opinion is it’s going to get a lot worse.”

And it’s not just the airlines with whom business aircraft operators must now compete to win or retain talent. Priester says a pilot who agreed to his offer to fly a Falcon 2000 later called to decline, explaining that another operator had just offered him $50,000 more. Unlike Priester’s offer, it involved no benefits, but the new employer would provide a three-bedroom house at no cost.

According to William Quinn, chairman and founder of Aviation Management Systems, a well-known business aviation consultancy in Portsmouth, New Hampshire, many charter and management firms “are having a hard time” attracting qualified pilots and as a result are having to lower their minima and increase pay.

Mike Aarons has a different perspective on the changed employment dynamic. He is a multi-thousand-hour business aviation pilot with several type ratings and an excellent work history, but when looking for a job in 2010, he says, “No one would talk to me. There was nothing out there.”

“Now,” he says, “you can almost write your own ticket.” He gets offers “practically daily” from regionals, along with business aviation operators. But the offer he accepted was Atlas Air’s to fly Boeings all over the world. He recently earned a 767 type rating—his 12th. And, he says, hopefully his last. He’s topped out and done, thanks to that vacuum.

Pilot Plunder

The challenge is keeping what you’ve got

NEW JOB JUST AHEAD

GUSTAVOFRAZAO / ISTOCK

William Garvey is Editor-in-Chief of Business & Commercial Aviation
ABOUT A YEAR AGO, THEN-AIRBUS
Commercial Aircraft CEO Fabrice Bregier sent a strong message to the industry. He publicly expressed his dismay at the performance of one particular supplier, Zodiac Aerospace. The French company had jeopardized A350 deliveries because its seats were late and other cabin monuments such as lavatories were incomplete. It was an unusual act; normally suppliers are not criticized publicly. So it was clear something had gone terribly wrong.

Airbus CEO Tom Enders earlier this month repeated the exercise. He pointed out that he had not only brought delays in CFM International Leap 1A engine deliveries to the attention of CFM’s own top management, but he had also alerted the joint venture’s parents, General Electric (GE) and Safran, about his observation that something was not working properly. Specifically, Leap engines again are arriving late at Airbus final assembly lines, holding up deliveries.

That Enders made the comments about CFM was, of course, no coincidence. He wanted to ratchet up the pressure but also show that Pratt & Whitney is not the only engine manufacturer in trouble. Pratt’s problems with the PW1100G have been a matter of public debate ever since Qatar Airways refused to take delivery of its A320neos, highlighting that the engine lacked maturity. And the latest issues forced Airbus to halt deliveries of Pratt-powered A320neo-family aircraft for several weeks, if not months.

Yet, in particular the technical difficulties in maturing and upgrading the PW1100G go beyond the normal teething problems to be expected when a new product is brought to market. The issues are severe; they are likely to cost Pratt a fortune, and they are a risk to its reputation, at least temporarily. The problems might even dent Pratt’s market share of the A320neo program if they are not corrected soon. After all, engine selection has yet to be made for a substantial portion of the aircraft’s firm order backlog. The company needs to look into what went wrong and what processes and oversight must be improved to avoid repetition of such flaws.

However, it is all too easy to blame the supply chain as a whole and the two engine manufacturers in particular. When Airbus and later Boeing launched their “new” A320neo and 737 MAX narrowbodies, they essentially dumped all the innovation responsibilities onto the engine manufacturers. The airframers themselves changed little, arguing the key technologies needed to develop all-new aircraft were not ready yet. Regardless of whether that was true, both airframers chose the low-risk and low-investment approach. They changed much less than Embraer did in the move to the new E2 from its E1. And Airbus was lucky that Pratt was desperate to find a way back into the narrowbody market, particularly after Rolls-Royce had turned it down in the hope of getting onboard for a new Boeing narrowbody that then was never developed. That almost all the technical and ramp-up difficulties are now related to engines should not come as a surprise.

And Airbus and Boeing demand a lot: They want a steep ramp-up of production that they themselves did not have to undergo—they simply were producing the same aircraft in greater numbers. Introducing new powerplants while almost at the same time driving output to unprecedented heights was asking for trouble.

It seems the warning signals are not yet sinking in. Just minutes after his comments about GE and Safran, Enders confirmed that studies had been conducted into increasing A320neo production to 70 aircraft per month and possibly more at a later stage. Airbus investors clearly were not scared by the outlook, driving Airbus shares up by more than 10% following his statement, the steepest increase in five years. Airbus is producing a growing amount of free cash and that will only rise with higher output, with a positive effect on dividends.

But the prospects of higher production volumes, revenues and profits will become realities only if bottlenecks are cleared. And engine suppliers are in the middle of the narrowest bottleneck. They should take a very careful look at their capabilities before committing to anything that puts even more strain on their facilities. Their shareholders may not like the possibility of massive cost overruns. The market fundamentals appear to justify production rates beyond what is planned, but the timing may not be right. Airbus and Boeing should listen to their suppliers and take their concerns seriously. Allowing them a little more time may benefit all parties and avoid premature and messy builds.
There is no line item conveniently labeled “SR-72” on which to hang the Pentagon’s renewed interest in hypersonics, but a comb through its fiscal 2019 defense budget request shows an uptick in funding for high-speed weapons and a shift from research to maturing systems for operational use.

Fiscal 2019 is poised to see first flights of the Defense Department’s two high-speed flagships: Tactical Boost Glide (TBG) and Hypersonic Air-breathing Weapon Concept (HAWC)—both air-launched strike missile demonstrators as well as joint programs involving DARPA and the U.S. Air Force Research Laboratory (AFRL).

The TBG is a rocket-boosted hypersonic glider, while the HAWC is a scramjet-powered high-speed cruise missile. Both are heirs to previous U.S. research efforts: the TBG to DARPA’s HTV-2, twice flown unsuccessfully in 2010-11; the HAWC to AFRL’s X-51A, which exceeded Mach 5 on its fourth and last flight in 2013.

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On Mars and take root, thereby complicating the opportunity to learn if the planet most like Earth in the Solar System ever hosted indigenous life.

Scientific rationale aside, the motivation for such measures, known as planetary protection, is rooted in law, namely the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies. The agreement, known as the Outer Space Treaty, has been the foundation for international space law since it went into effect in October 1967. It has been signed and ratified by 105 countries, according to the United Nations website.

The FAA, which reviews payloads as part of the process for granting a U.S. company permission to launch, offered a nebulous response to the question of whether it considered planetary protection issues in licensing Falcon Heavy’s launch.

“Pursuant to 51 USC 50919, the FAA licenses launches only if they are consistent with the United States’ international obligations, including those assumed in treaties. The United States is a signatory to the Outer Space Treaty, and Article IX of the Outer Space Treaty requires that space exploration be conducted so as to avoid harmful contamination,” the FAA wrote in an email.

Left unsaid in the FAA’s response, however, is that Article IX of the Outer Space Treaty legally applies only to countries, not commercial companies. “The treaty says governments shall conduct their exploration—in other words NASA launches, [Department of Defense] launches—to avoid harmful contamination, and as a legal matter that treaty provision does not apply to private parties. When the treaty drafters wanted things to apply to private parties, they said so,” says Laura Montgomery, an adjunct professor at Catholic University’s Columbus School of Law and former FAA space law branch manager.

“The Supreme Court reads treaties like contracts: You agree with what you wrote down . . . not on what you might want it to say,” she says.

In part, Article IX says, “States Parties to the Treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose.”

The FAA declined to say if a probability of Mars impact was included in its assessment of SpaceX’s launch application. It delved into the issue of commercial missions beyond Earth orbit in 2015 at the request of Bigelow Aerospace, the Las Vegas-based designer of expandable space habitats. The company, owned and run by hotelier and entrepreneur Robert Bigelow, sought to expand the FAA’s regulatory purview by having it acknowledge that another tenet of the Outer Space Treaty, namely the ability to conduct missions on a non interference basis, applied to commercial lunar surface activities, such as mining around a privately owned base.

In 2016, the FAA took another step on behalf of Cape Canaveral-based Moon Express, which had asked for a payload review of a mission to fly a small spacecraft to the lunar surface. After months of discussion, U.S. officials agreed with the company’s proposals for fulfilling U.S. compliance with the Outer Space Treaty, including voluntarily submitting to a planetary protection assessment by NASA.

The Bigelow Aerospace and Moon Express missions are pending, but in granting an actual license to launch Falcon Heavy and its cosmic car, SpaceX has now become the first commercial company to fly a mission beyond Earth orbit. The car will pass within about 69 million mi. of Mars in June, reach Mars’ orbit in July and its farthest point from the Sun—some 158 million mi.—in November before heading back toward the inner Solar System, essentially becoming an Earth-Mars cycler—and legal precedent—for the foreseeable future.
The service’s fiscal 2019 budget request seeks more than $1 billion through fiscal 2023 for a Boeing B-52 Stratofortress propulsion system replacement program. The initiative would replace the Pratt & Whitney TF33-103, which has powered the H-model B-52 since its introduction in 1960. But unlike the KC-135R refueling aircraft upgrade, which swapped four TF33s for four CFM International CFM56s, the Air Force is shooting for a straight “eight for eight” swap on the B-52, rather than attempting to install four large high-bypass turbofans.

This is a major opportunity for turbofan manufacturers GE Aviation, Pratt & Whitney, Rolls-Royce and potentially Safran, which are now lining up to compete.

The program has been gathering momentum over the past two years, but it received a significant bump on Feb. 12, when the Air Force released its budget proposal.

Having now decided to keep the B-52 around until 2050, while replacing Rockwell B-1Bs and Northrop Grumman B-2s with Northrop B-21 Raider stealth bombers, the service’s fiscal 2019 proposal would launch nine new B-52 modernization programs. The largest of them is the reengining, which will be pursued concurrently with a major radar upgrade.

According to budget documents, funding for B-52 modernization will peak at more than $560 million in fiscal 2021.

If the engine upgrade is approved and funded by Congress, the service will seek a prime system integrator and engine manufacturer to deliver up to 650 new engines, including spares. The initial buy would be 20 engines for integration and testing on the first two B-52s in the 2022-23 time frame.

GE Aviation tells Aviation Week that it could put forward its required thrust class, the Passport, which powers Bombardier’s newly developed Global 7000 business jet and has been selected for the proposed Global 8000.

The high-bypass turbofan was launched in 2010 and certified by the FAA in April 2016. It has been certified in three thrust ratings (17,745 lb., 18,435 lb. and 18,920 lb.) and will enter service later this year when the Global 7000 is fully certified and delivered.

The company still has not ruled out offering a version of the CF34-10, a modern civil derivative of the TF34 military engine that powers the Fairchild A-10 Warthog. The CF34-10 is designed for narrowbody regional jets but could also make an economical eight-engine replacement for the B-52, GE Aviation says.

The company’s expanded offering for the prospective B-52 propulsion upgrade comes on the heels of a December 2017 industry day during which the Air Force first presented its requirement for up to 650 engines. The proposed engine solution must achieve a 10-15% fuel-burn reduction and be supportable for the next 40 years, with 15-25 years of utilization before the first scheduled depot overhaul.

GE Aviation is not the only horse in the race. Rolls-Royce would offer one...
Having now decided to keep the B-1B in its inventory, the Air Force is weighing the options of replacing the Pratt & Whitney engine with another model or sticking with its current engine, the TF33. The Air Force is considering the Pratt & Whitney PW800-series turbofan, or the CF34-10, which has been in service for decades and is more widely used. The CF34-10 offers “cutting-edge performance and efficiency,” with a 52-in.-dia. fan, which could achieve 27% better specific fuel consumption compared to the TF33.

Safran has also been attending the industry days, but has not yet announced its intention to bid. Karl Sheldon, vice president and general manager of GE’s large military engines business, tells Aviation Week that the final decision on which engine GE will ultimately propose depends on the requirements and priorities of the Air Force. He notes that the TF33 is not supportable beyond 2030, and an eight-for-eight engine swap is the only viable path forward. GE has already replaced the engines on the Boeing KC-135R tanker and Lockheed Martin C-5M transport and is now keen to upgrade the service’s oldest bomber.

The CF34-10 has been in service longer and is more widely used, but Sheldon says the Passport, with a 52-in.-dia. fan, offers “cutting-edge performance and efficiency.” It could achieve 27% better specific fuel consumption compared to the TF33, while increasing the B-52’s range by more than 30%, he says. By comparison, the CF34, with a 53-in.-dia. fan, would offer 20% better specific fuel consumption, while also boosting the bomber’s range.

“We have been looking at B-52 re-engining for a long time—decades, actually,” Sheldon explains. “Back then, the Passport was not even an option. The timing of the Passport entering service and the Air Force seeking to reengine the B-52 is fortuitous.”

To fit on the B-52, the engines would be side-mounted on a customized twin pod. The aim is to minimize any changes to the fan diameter, weight and center of mass to avoid a costly recertification effort for the entire B-52 aircraft, including stores and conventional armaments.

The Passport engine is built at GE Aviation’s plant in Strother, Kansas, and the bulk of the CF34 work is performed at Strother and Lynn, Massachusetts. However, Sheldon says for an engine order this large, if selected, GE may decide to expand into another production facility.
Boeing Backs Two Sides of MQ-25 Competition

BOEING AND GA-ASI MAKE STRANGE BEDFELLOWS

SKUNK WORKS ABANDONS UCLASS SEA GHOST

B

oing has backed two sides of the U.S. Navy’s multibillion-dollar MQ-25 Stingray competition, with General Atomics Aeronautical Systems (GA-ASI) announcing a partnership with the aerospace heavyweight’s autonomous systems group in the pursuit.

In January, Boeing Defense, Space and Security’s (BDS) Phantom Works revealed the first images of its prospective MQ-25 Carrier-Based Aerial Refueling System, an oddly shaped wing-body-tail aircraft with long wings and low-hanging ruddervators. A prototype of the clean-sheet UAV has since been spotted undergoing testing outside Boeing’s military aircraft plant in St. Louis.

With one strong offering already put forward for MQ-25, it was surprising to see Boeing also top GA-ASI’s list of key industry partners for a rival bid. The U.S.’s leading manufacturer of armed drones, GA-ASI has offered a heavily redesigned naval derivative of its Predator C “Avenger” for the aerial tanking mission.

Along with Boeing Autonomous Systems, General Atomics has allied with BAE Systems, GKN Aerospace Fokker, L3 Technologies, Pratt & Whitney Military Engines, Rockwell Collins and UTC Aerospace Systems.

GA-ASI’s MQ-25A Stingray “will more than double the range of the Carrier Air Wing,” the company said in a Feb. 12 announcement. “Our offering exceeds all of the Navy’s requirements, including carrier suitability.”

The aircraft will be powered by Pratt & Whitney Canada’s PW815 high-bypass turbofan, which is being introduced on Gulfstream’s 6,200-nm-range G600 business jet.

Meanwhile, UTC Aerospace Systems has been selected for the GA-ASI MQ-25’s landing gear, and Fokker of GKN Aerospace for the arresting hook. L3 Technologies is providing line-of-sight and beyond-line-of-sight communications systems, while Rockwell Collins contributes “advanced navigation technologies” and the TruNet ARC-210 networked communications airborne radio. BAE Systems leads mission planning and cybersecurity.

GA-ASI says it will also leverage the experience of its sister companies, General Atomics Systems Integration and General Atomics Electromagnetic Systems.

General Atomics is best known for its family of armed Predator UAVs, the most operationally active being the U.S. Air Force’s MQ-9 Reaper and the Army’s MQ-1C Gray Eagle.

Boeing Autonomous Systems emerged out of a company restructuring in June 2017, which saw BDS reorganize into seven key divisions. It is responsible for unmanned products, including among others the Insitu ScanEagle, RQ-21 Blackjack, QF-16 full-scale aerial target, Phantom Express, X-37B, Wave Glider, and Echo Voyager; and presumably the MQ-25 if it transitions into production and deployment.

Boeing characterized its multipronged approach to the MQ-25 competition as a solid business strategy. “Pursuing the program as a prime bidder and [as] a member of the General Atomics team is good for our customer and reflects our focus on doing what’s necessary to compete, win and grow,” Boeing spokeswoman Mary McAdam says.

Boeing and General Atomics have been chasing the Navy’s carrier-based drone requirement as rivals for over a decade, but came together sometime before responding to the Oct. 4, 2017, MQ-25 request for proposals.

Lockheed Martin Skunk Works is the third and final contender since Northrop Grumman chose not to compete. It opted out in October, exiting one of the most consequential and potentially rewarding UAV programs in Navy history.

So far, Boeing and General Atomics have released images of their competing airframes, but Lockheed is keeping a close hold on its proposed design.

Back when the Navy was seeking a carrier-launched surveillance and strike platform, Lockheed pitched a version of its classified RQ-170 Sentinel, called Sea Ghost. But the company tells Aviation Week that its version of MQ-25 has been reworked top to bottom, to meet the new requirements for long-range aerial tanking and light maritime surveillance.

“Our purpose-built MQ-25 is optimized for probe-and-drogue tanking performance and carrier integration to meet the Navy’s critical refueling needs while also providing opportunity for capability growth,” says Craig Johnson, Skunk Works’ MQ-25 capture manager.

Johnson says to reduce cost and expedite development, the Skunk Works MQ-25 reuses a significant amount of pre-certified hardware and software.

The MQ-25 will replace “buddy pod”-equipped Boeing F/A-18E/F Super Hornets in their current aerial tanker role aboard the Navy’s fleet of Nimitz- and Ford-class aircraft carriers.

The winning team will proceed into the full-scale development phase, which includes delivery of four test aircraft. Once developed, the Navy will decide whether to continue into production and fielding, with a requirement for up to 72 aircraft.

Funding for MQ-25 development almost quadrupled from this year to next; the Navy is requesting $719 million for fiscal 2019. It has earmarked over $3.3 billion for MQ-25 research, development, test and evaluation through fiscal 2023.  

General Atomics Aeronautical Systems has offered an enlarged, navalized version of the “Avenger” for the Navy’s MQ-25 tanker UAV competition.
New Partner-Nation Deal Should ‘Reduce the Bleeding’ on A400M

Tony Osborne London

The A400M partner nations have thrown Airbus another lifeline as the company continues its struggle to bring the airlifter’s tactical capabilities online.

The new deal, agreed through a Feb. 7 declaration of intent expected to be signed in the coming months, will rebaseline the program and “further mitigate risks remaining on the A400M program,” Airbus CEO Tom Enders says.

Airbus has so far delivered nearly 60 A400Ms to six of the eight customer nations, but the program has already taken more than €7 billion ($8.6 billion) in losses over the last eight years, with a €2.2 billion charge in 2016 alone, followed by €1.3 billion announced on Feb. 15, all resulting from penalties for the late delivery of aircraft, tactical capabilities and engine problems that have dogged the aircraft.

Enders says the company remains committed to the A400M, but the program has suffered from “operational issues” as well as what he called a “flawed contractual setup and insufficient budget.”

The new deal will provide “a good chance to stop or at least reduce the bleeding now and deliver the capabilities our customers need,” he says.

The 2016 charges were the prompt for Enders to restart negotiations with the A400M partner nations—Belgium, France, Germany, Luxembourg, Spain, Turkey and the UK—to try to loosen the program’s financial stranglehold on Airbus’ defense business.

Enders says the A400M has become a “Damocles sword” hanging over the company. Airbus, he says, has taken on a “lopsided share” of the risk on the program, including, unusually, risk related to the Europrop International (EPI) TP400 engine.

The contract amendment—agreed by Airbus, the partner nations and the European defense materiel agency, OCCAR—includes a new delivery plan, an adjusted road map for the A400M’s tactical capabilities and an amended timetable for retrofitting early-build aircraft.

Airbus confirmed in January that the airlifter production rate will be slowed starting this year: The company plans to deliver 15 aircraft during 2018 and 11 aircraft in 2019, having delivered 19 in 2017. Beyond 2019, production rates could fall to just eight aircraft a year unless export orders emerge. So far, the only export order has come from Malaysia, whose four aircraft have now all been delivered.

However, last year Airbus did bid the A400M for several competitions, including in New Zealand (AW&ST Feb. 12-25, p. 37).

The new delivery plan will mean Belgium, which had planned to take delivery of its first aircraft in 2019, will now receive it in 2020.

The production slowdown should also suit several of the partner nations that have attempted to offload some of their orders due to budgetary issues.

France officially has 50 A400Ms on order but plans for just 25 to be in service by the end of 2025, according to its recently published military program law.

Issues with the delivery of military capabilities have been a frustration for several nations. Germany has criticized the program strongly, as it is having to retain several of its elderly C-160 Transall transports. France and Germany are also planning to purchase tanker versions of the Lockheed Martin C-130J Hercules because of difficulties in developing the A400M’s helicopter-refueling capability.

Airbus Defense and Space CEO Dirk Hoke told Aviation Week at the Dubai Airshow last November that the company has made “good progress” in the development of tactical capabilities in key areas such as dropping supplies and troops, self-defense and helicopter air-to-air refueling.

The company is working with Cobham on the development of a modified refueling pod and hose that can extend farther from the A400M, allowing helicopters to refuel in cleaner, less turbulent air away from the airlifter to reduce the risk of potential collision between tanker and receiver.

The French Air Force has reportedly said aircraft availability stands at 35-40%, largely because of issues with the TP400 engine that led to an in-flight engine shutdown in early 2016. Problems with the engine’s power gearbox are being solved more slowly than hoped. The fix, known as Pack 2, addresses problems with the input pinion plug, which was found to be prone to cracking. Europrop International is in the process of completing development of the Pack 2 fix, which is due to be certified during the first quarter of 2018, and engines will be retrofitted during engine shop visits, the engine consortium told Aviation Week.

Belgium to Receive First A400M in 2020

Final Power Gearbox Fix to Be Delivered in 2018 Q1

Some customers will draw out their A400M airlifter deliveries.
Nuclear neighbors India and Pakistan are undergoing a particularly violent late winter on their shared border in the Kashmir region. The violence has effectively dismantled a cease-fire negotiated in 2003 in response to a terror attack on India’s Parliament in 2001 by extremist groups based in Pakistan.

In response to those heightened tensions, India is accelerating weapons and equipment purchases that usually meander through the country’s notoriously slow military procurement process. And the government aims to speed acquisition of unmanned aircraft systems (UAS), in particular.

The trend can be traced to September 2016, when the Indian government ordered an army special-forces mission across the cease-fire line. An unmanned Indian Air Force Heron provided visual intelligence to commando teams before they attacked at least four Pakistani militant staging areas.

In response to those heightened tensions, India is accelerating weapons and equipment purchases that were slow to yield a contract. But there has been significant progress on another, more contentious front. India will begin accepting deliveries of 10 Israeli-built Heron TPs—the Indian military’s first armed UAS—this year as part of a contract concluded in 2015.

India already operates a small number of Israeli Harop loitering anti-radiation UAS but has had steadily rising interest in acquiring the sort of ISR capability that U.S. forces wield on the Afghanistan-Pakistan border and elsewhere.

Alongside entry of the Heron TPs, India will be angling for a possible transfer of General Atomics Predator C/Avenger armed UAS from the U.S. as part of a Foreign Military Sale. A request for such systems during President Barack Obama’s administration was met instead with an offer of 22 unarmed General Atomics MQ-9B Sea Guardian maritime long-endurance surveillance UAS.

David Alexander, president of Aircraft Systems at General Atomics Aeronautical Systems, says he hopes interest in Avenging by a foreign customer—widely believed to be India—will result in a sale. It remains unclear when a sale would happen, but current tensions between India and Pakistan have added urgency.

Still, uncertainty remains. With India looking to build single- and twin-engine manned fighter aircraft, it faces huge budgetary constraints on the potential import of high-performance systems. The government’s focus is on a “Make in India” production line, with Lockheed Martin’s F-16 Block 70 from the U.S. and Swedish company Saab’s Gripen E in contention. Adding to the financial squeeze will be big payments flowing toward the purchase of 36 Dassault Rafale fighters from France.

On the homefront, India’s own ambitious UAS development programs are likely to see higher levels of funding this year. But India’s Tapa medium-altitude long-endurance UAS, which began flight testing in late 2016, is still a long way from being mission-ready.

The much more complex Ghatak flying wing stealth combat UAS is on track to be declared a full-fledged project this year, with attendant funding channels and time lines. Though at least seven years away from flight testing, India’s state-owned Defense Research and Development Organization hopes to get started on the Ghatak by the end of this year, when it will put a cloned miniature designated SWIFT (stealth wing flying testbed) into the air.

While airstrikes officially have been on the table for India—most recently after the Pakistani militant attack on an Indian Army camp in 2016 and most notably after the November 2008 terror attacks in Mumbai by Pakistani terrorists—the rules of engagement and doctrine for UAS use remain in development.

On both occasions, India decided not to conduct air strikes from UAS on terrorist training camps across the cease-fire line because of the risk of triggering a full-scale confrontation. But the emphasis on armed UAS suggests the country is keeping that option open.
Embracing Uncertainty Lets Drones Fly Unknown Routes Fast

DEPTH SENSOR TELLS NANOMAP WHERE IT CAN SAFELY FLY

NANOMAP LOOKS BACK AT SNAPSHOTS OF SURROUNDINGS WHEN IT BACKTRACKS

Kelsey Atherton Albuquerque, New Mexico

For drones to transform daily life, they will have to move beyond pilots. Unmanned aircraft envisioned for everything from package delivery and rescue work to agricultural survey and military scouting still require pilots or direct operators.

Those human pilots either fly the UAV with a joystick, like a remote-control aircraft, or guide the drone by entering waypoints, monitoring and navigating the vehicle as it maneuvers. Both approaches limit where UAVs can go and how they can fly, and if drones are going to navigate complex environments such as cities or forests without the aid of skilled pilots, then they will need to learn how to fly themselves in unfamiliar environments.

The Massachusetts Institute of Technology’s Computer Science and Artificial Intelligence Laboratory (CSAIL) has introduced NanoMap, a tool that lets drones do exactly that.

For people as well as drones, the simplest way to navigate between two points in unfamiliar terrain is to have a map. Unlike a human driving a car, however, a drone is moving in three dimensions and outside a laboratory, that mostly means unmapped spaces.

Mapping the interior of every location or the exact contours of the space between every tree in every forest are impossible tasks. As a result, many navigation systems for drones use a depth sensor and then map the space around the vehicle in real time, allowing the UAV to move as the map is made.

That means the drone can fly only as fast as the world ahead of it is mapped.

NanoMap also uses a depth sensor to plot where it is safe for the drone to fly. But rather than stitching together a map of the space around the drone,

Modeling uncertainty reduces the crash rate due to a 5% drift in the drone’s position to 2% from 28%.

the sensor takes snapshots of the world ahead of the vehicle and then, if the drone has to maneuver around a sudden obstacle, NanoMap looks back through the previously taken images, piecing together any information about where the drone is going from what it has already seen.

“The problem is that such data can be both unreliable and hard to gather quickly,” says CSAIL. At high speeds, computer-vision algorithms cannot make much sense of their surroundings, it says, forcing the drone to rely on inexact data from its inertial measurement unit, which senses the vehicle’s acceleration and rate of rotation.

“The way NanoMap handles this is that it essentially doesn’t sweat the minor details,” says the lab. “It operates under the assumption that to avoid an obstacle you don’t have to take 100 different measurements and find the average to figure out its exact location in space. Instead, you can simply gather enough information to know that the object is in a general area.”

By processing images rapidly, and by accounting for uncertainty, a quadcopter using NanoMap can fly at speeds of up to 20 mph, even through obstacle-rich environments such as a forest or a warehouse.

The speed at which an autonomous drone can fly is limited by its need to be certain about its position.

out fear that it will crash and damage whatever it is carrying.

According to CSAIL, when NanoMap was not modeling uncertainty, and the drone drifted just 5% away from where it was expected to be, the vehicle would crash more than once in every four flights. “When it accounted for uncertainty, the crash rate reduced to 2%,” the lab says.

Video See how NanoMap helps a drone navigate challenging environments. AviationWeek.com/NanoMap
The helicopter service Voom is the first project to graduate from Airbus’ Silicon Valley incubator, A³, and has become a subsidiary of Airbus Helicopters. Voom began operations in April 2017, in Sao Paulo. With backing from Airbus Helicopters, the service soon will expand into Mexico City, which has similarly congested road traffic, but with the additional challenge for helicopter air taxis of hot-and-high operating conditions.

Since the online booking service began, using approved Part 135 helicopter operators and licensed heliports already in place in Sao Paulo, Voom says monthly growth has exceeded 200% in number of trips and 220% in riders. The service now makes “several dozen trips a day” between eight heliports, six in the city center and two at Sao Paulo’s domestic and international airports, says CEO Uma Subramanian. “And we have just scratched the surface.”

Crucially for Airbus’ urban air mobility initiative, “we are learning a lot about how people fly, where they want to go, and what they think about luggage,” she says. “That’s important to the next-generation vehicle and what operating costs should look like for future vehicles.”

Most electric vertical-takeoff-and-landing (eVTOL) air taxis are being designed for four passengers, but if they bring a lot of bags, “it could radically change the equation,” Subramanian says.

When booking with Voom, customers must say how much luggage they plan to bring, as it can require a larger helicopter, which drives up the cost. Some 60% of riders come with one or more checked bags, so Voom has paid one of its operators to add a luggage tray to its helicopter for airport routes.

Voom also is learning what routes customers want to travel. “It’s not just the airports. We have fairly regular business travelers who want to get from one end of town to the other,” Subramanian notes. “This is important to scaling the network in the future and to what we do [with larger helicopters] in quiet times.”

Airbus also is learning what passengers consider a fair price. “We have to think about vehicle design as a function of willingness to pay for an air transport service,” she says. If the goal is to offer lower operating costs per mile than a premium helicopter service, to increase usage, the questions are: “What is the delta, and what does the next-generation vehicle look like at that price?”

What Airbus thinks that vehicle could look like is the four-seat CityAirbus eVTOL. At roughly 26 ft. (8 m) in length and width, this will be smaller than any helicopter Airbus produces and, while styled to resemble the twin-turbine H160, it will be a rather utilitarian aircraft. “It is not a sports car,” says Marius Bebesel, Airbus head of urban air mobility. “People will only spend 15-30 min. in this vehicle, so it will be more like a London taxi.”

Propulsion for the 4,850-lb. (2.2-metric-ton) demonstrator aircraft is provided by eight 100-kW Siemens SP200D motors, a total output more than twice what is needed to hover.
“We are still learning. The motors are oversized, as are many of the systems onboard, so there is room for optimization,” Bebesel says.

Safety is one driver for this conservative approach, with a high level of redundancy applied to major systems. If one motor shuts down, the other seven will more than take the strain without passengers noticing. Each of the eight motors drives fixed-pitch propellers, mounted in contra-rotating pairs with one inside the duct, the other raised just above it. The ducts increase performance but also are aerodynamically shaped to reduce drag in forward flight while providing some additional lift in cruise.

The propeller shafts are the only mechanical parts on the aircraft, which will have a “big impact on operational costs,” Bebesel says. “We have an image of maintenance on this aircraft being done by one guy with a torque meter,” while the rest of the systems onboard will be self-monitoring.

One key focus is on passenger comfort, particularly in the first seconds after takeoff as the CityAirbus transitions to forward flight.

There is concern that a helicopter-like nose-down transition could be uncomfortable for some, so Airbus is working on maintaining level flight throughout the mission. The company is filing for a patent on technologies that could achieve this.

Because the CityAirbus is designed to operate in sensitive urban areas, engineers are studying how to keep noise levels low. Electric motors help, but using contra-rotating propellers in the ducts can result in unwanted noise from blade interactions, so tip speed is reduced to 395 fps (120 m/s) compared to the 690 fps in a traditional helicopter.

Behind the cabin, Airbus is suspending the four 100-kWh lithium-ion batteries on a rail that allows them to be moved to adjust the center of gravity during flight testing. Suspending them high in the fuselage also improves handling and flight characteristics, Bebesel says.

Airbus powered up a ground-test rig for the CityAirbus propulsion and flight control systems at the end of 2017 and is aiming to fly the demonstrator, unmanned, at the end of 2018. The first hop will take place in Donauworth, Germany, before testing is transferred to the nearby military airfield at Manching.

Once early testing is complete, the aircraft will be converted for manned flights. While initial commercial flights could be piloted, ultimately the CityAirbus would fly autonomously between preassigned stations. Passengers would walk under the ducted fans to enter the cabin, but as they are 6.4 ft. off the ground, only a handful would have to duck.

Props can be stopped within 2 sec., which should speed up turnaround times, allowing passengers to leave the vehicle moments after landing, unlike a helicopter, where they might wait for rotor blades to stop turning before exiting.

Because the CityAirbus is carrying its 1,100-lb. (500-kg) energy source at all times, a key driver has been to keep weight low. The airframe itself is only about 10% of the vehicle’s empty weight. Motors and inverters feature separate liquid cooling systems, although Bebesel says production systems likely would have a more simplified approach. Artificial intelligence also would play a role, with the electrical systems calculating the temperature and charge status so it can be optimized for the upcoming flight.

Another lesson from Voom’s first 10 months of operations in Sao Paulo? “Weather can be a real problem. In January, we had to cancel 21 trips in 1.5 hr.,” Subramanian says. “We need to be thinking about how weather factors in, and we need to design the vehicle to deliver a reliable product, even in inclement weather.”

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**Safety and low noise are driving the design of the CityAirbus.**
Additional nations may join the International Space Station (ISS) partnership as part of a plan to wean NASA from direct funding of the outpost in 2025. Fifteen nations, led by the U.S. and Russia, jointly own and operate the ISS, which has been permanently staffed by rotating crews of astronauts and cosmonauts since November 2000. The Trump administration's fiscal 2019 $19.9 billion spending plan for NASA allocates $3.6 billion for the ISS, including $2.1 billion for crew and cargo transportation costs. The ISS and space transportation budgets are expected to ramp down and level off at about $3.2 billion through fiscal 2023. Pending Congressional approval, NASA would end its direct support of the ISS in 2025.

Thereafter, the agency’s microgravity science projects and technology demonstrations for long-duration habitats and activities beyond low Earth orbit (LEO) would continue aboard commercial spacecraft. The Trump administration proposes spending about $890 million over five years to stimulate commercial LEO platforms and capabilities.

“Starting in 2018, we will increase the depth and breadth of the commercial and international low-Earth-ordinate activities,” specifically, we will offer to expand the International Space Station partnerships to new nations. Based on inputs from our current ISS and commercial stakeholders, we will shape the plan to transition the International Space Station, as we have been asked to go do,” NASA Acting Administrator Robert Lightfoot said during a National Space Council meeting at Kennedy Space Center on Feb. 21.

The council, headed by Vice President Mike Pence, was re-established by President Donald Trump in June to coordinate space policy and activities across all branches of government.

Lightfoot did not mention any potential new ISS partner nations by name, but China's growing technical prowess in space was discussed throughout the 2-hr. meeting. Nano-Racks CEO Jeffrey Manber pointed out that European Space Agency astronauts already are training to visit China’s planned space station, slated for construction in LEO between 2019 and 2022.

“The United States cannot simply ignore China’s commercial space ambitions. China is quietly developing a robust commercial space industry. I say ‘quietly’ because Americans are barred, by our own regulations and our own mindset, from participation in this marketplace,” says Manber. “Avoiding this emerging marketplace, albeit [due] to justified concerns over technology transfer and other legitimate issues, is not the American global leadership that we all strive to achieve.”

Dean Cheng, a senior research fellow at The Heritage Foundation, told council members: “China is fundamentally a major space power. ... Above all, it has the political will to support and sustain national commitments to space. China has also committed the industrial, financial and human capital to translate those desires into today’s array of satellites, boosters and launch sites.

“China may engage in all sorts of industrial espionage, but much of its space program is indigenous and homegrown,” says Cheng, adding that its program has a very heavy military component. “When we interact with China’s space program, we are essentially interacting with China’s military.”

The council agreed to forward to Trump several policy recommendations to ease U.S. regulations and support commercial space initiatives, including:

- Requiring a single license for all types of launch and reentry vehicle operations by March 1, 2019. “Our ultimate aim is a ‘file-and-fly’ kind of licensing framework,” says Transportation Department Deputy Secretary Jeffrey Rosen.
- Except for launch and reentry licensing, consolidating commercial space oversight in the Office of the Secretary of Commerce and developing a legislative proposal by July 1 to create an undersecretary of space commerce who would be responsible for all commercial space regulatory functions.
- In coordination with the secretaries of state and defense, the Federal Communications Commission and NASA, authorizing the secretary of commerce to streamline licensing for commercial remote-sensing operations and address new issues, including radio-frequency spectrum allocations and spacecraft rendezvous and docking operations.

The council also plans to review current export licensing regulations that affect commercial space activities and make any recommendations for changes by Jan. 1.
Asia-Pacific Proves Fertile Ground for New Widebody Versions

SINGAPORE AIRLINES TO LAUNCH FIRST BOEING 787-10s, AIRBUS A350-900ULRs IN 2018

CATHAY PACIFIC WILL ADD A350-1000s, AS AIRBUS LOOKS FOR MORE SALES

Adrian Schofield  Auckland

Singapore airlines are set to play key roles in the debuts of new widebody variants this year, and they also are driving manufacturers to extract even more range from their latest offerings.

Singapore Airlines (SIA) is due to be the first to fly Boeing’s stretched 787-10, and later this year is slated to deploy the initial ultra-long-range (ULR) version of the Airbus A350-900. Meanwhile, Cathay Pacific Airways is destined to be the second customer to receive the A350-1000. And in the longer term, Qantas Airways and Air New Zealand have set challenging range targets for manufacturers that could be met by further tweaking the performance of the Airbus A350 and Boeing 777X models.

As with the other carriers, SIA expects the new models to enable it to access new markets or operate existing routes more efficiently.

The first 787-10 is expected to arrive in Singapore on March 28. SIA has 49 of the -10s on order, although it is not revealing how many it is likely to receive in its fiscal year beginning April 1.

SIA plans to switch its Singapore-Osaka, Japan, route to -10s in May, but before then the aircraft will be flown on selected services to destinations such as Bangkok and Kuala Lumpur for crew training. The airline generally intends to use the -10 for flights within the Asia-Pacific region. With this in mind, SIA is introducing new “regional cabin products” on this fleet, featuring 36 seats in business class and 301 in economy.

Boeing had received 171 orders for the 787-10 through January. SIA is the largest customer, and other Asian carriers also have placed orders, including Taiwan’s Eva Air, with 18, and All Nippon Airways, with three. More sales from this region could be forthcoming, as some carriers have indicated interest in the -10 as they consider widebody orders.

Fewer timing details are available regarding the launch of the A350-900ULR, of which SIA has ordered seven. The first aircraft are expected to be delivered in the second half of 2018. SIA may have more to say when it releases its next fleet update as part of its fiscal full-year results in May.

SIA plans to use the -900ULRs on nonstop flights to North America, initially from Singapore to Los Angeles and New York. The carrier last operated these as nonstops using Airbus A340-500s but terminated the routes in 2013 and phased out the less-efficient -500s. SIA currently serves both destinations with one-stop flights, via Seoul and Tokyo for Los Angeles and via Frankfurt for New York.

This year also has seen the launch of the A350-1000, the longer cousin of the A350-900. Qatar Airways received the first delivery Feb. 20, and Cathay is expected to become the second customer around the middle of this year.

Cathay plans to use its initial -1000s to launch a route from Hong Kong to Washington in September, which will be the airline’s longest nonstop flight. Cathay will also use the -1000s on most of its Tel Aviv services from October onward. The carrier has 20 -1000s on order, and they generally will replace other aircraft types on high-demand routes.

Airbus is attempting to generate more sales for the -1000 from Asia-Pacific airlines. The manufacturer recently completed a 12-country tour through the Middle East, Asia and Australasia with a -1000 test aircraft, partly to showcase the aircraft in po-
Qatar Airways’ receipt of the first A350-1000—a stretched version of the in-service A350-900—marks the entry into a critical sales period for the program, given Airbus’ ambitions against the Boeing 777. As Boeing is developing the 777-8X and -9X, Airbus predicts greater potential for improvement, thanks to the A350’s relative youth.

The A350-1000’s market positioning is a big gamble. Designed as a 777-300ER killer, the 366-seat aircraft has indeed won market share, and its success partly explains why Boeing cut the 777’s production rate. But the A350-1000’s orderbook, at 169, has shrunk since its first flight in 2016, when it stood at 195.

To benefit from the upcoming replacement need for the Boeing 777-300ER, the A350-1000 will have to wait. A wave of replacements is expected in 2022-23, according to Fabrice Bregier, whose last day as Airbus Commercial Aircraft president was Feb. 20. “Now is the time to be more aggressive [in sales],” he says. The Boeing 777X variants are slated to enter service in 2020 and 2022. Bregier contends they could be “too big” for many 777-300ER operators and maintains the A350 has a fuel-burn advantage.

Airbus must make a strong case for the A350-1000 over the next few years. One way may be by emphasizing its reliability. The A350 XWB, a new-generation aircraft, has many more sensors and is much more connected than older widebodies. Therefore, more data is available to customer support experts. The -900’s dispatch reliability already stands at 99.3%, three years into service. This is due to “the way we listen to the aircraft,” Airbus Head of Programs Didier Evrard says. With more data and analysis, solving or mitigating problems becomes much faster, he points out.

As the A350-1000 fleet grows, Airbus engineers will take a similar approach. Rolls-Royce will work in parallel on the Trent XWB-97 engine, which will follow on from the measured 99.9% dispatch reliability of the A350-900’s Trent XWB-84. The hope, therefore, is that the A350-1000 will swiftly build confidence with potential customers.

Another enticement for those carriers contemplating 777-300ER replacement may be the incremental improvements possible because of clean-sheet design.

Thierry Dubois Toulouse and Kurt Hofmann Doha, Qatar

< AIRBUS BETS A350-1000 WILL OUTSTRIPE BOEING 777X >

RELIABILITY TO BENEFIT BOEING 777X
> INCREMENTAL IMPROVEMENTS POSSIBLE BECAUSE OF CLEAN-SHEET DESIGN

The A350-1000 typically seats 366 passengers, although Qatar Airways has chosen a more spacious layout for 327.

Asian airlines account for 43 of the 169 orders for the -1000. In addition to Cathay, Japan Airlines has ordered 13, and Asiana Airlines 10.

Sales have been slow for the -1000 compared to the early success of the -900. The -1000 is partly aimed at replacing Boeing 777-300ERs, but that fleet is still relatively young, notes A350 marketing head Maria Luisa Lucas-Ugena. This means replacement orders are taking longer to emerge. However, there are also new sales opportunities linked to fleet growth, particularly in Asia, she says.

Asia has proven to be a successful market for the A350 family, mainly due to the -900. There have been 854 orders for A350s globally, of which 287—more than a third—are from Asia-Pacific. Fourteen of the 45 A350 customers are from the region, and eight airlines there already are operating A350s.

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Qantas has challenged the manufacturers to propose an aircraft that can fly between Sydney and London nonstop while meeting its load criteria. CEO Alan Joyce recently said the carrier will likely issue a request for proposals (RFP) in 2019. The carrier aims to begin flying these services around 2022 if a suitable aircraft can be ordered.

Airbus and Boeing are working to modify the specifications of their long-range widebodies to match the Qantas requirements. Airbus has indicated it will offer the A350-900ULR for the Qantas competition, while Boeing will propose its 777X program. These two types also are expected to be proposed to Air New Zealand to meet its goal of flying nonstop from its Auckland base to the U.S. East Coast. The carrier is planning to issue an RFP this year, which would provide more details on its requirements. These aircraft will replace the airline’s Boeing 777-200ERs, which have an average age of nearly 12 years. The replacement will begin in the first half of the next decade, the carrier says.

same with the -1000 [which tips the scales at 311 tons],” Marisa Lucas, head of A350 XWB marketing, says. On the -1000, Airbus has introduced aerodynamic changes such as a wing twist, extended winglets and tweaked flaps and fairings for enhanced fuel efficiency. The changes will also benefit the -900, the first being Iberia’s. Combined with the increased MTOW, they will yield a 1% fuel-burn reduction over a typical mission, according to an Airbus spokesperson.

In aerostuctures, the percentage of carbon-fiber-based composites has reached 54% on the -1000, up from 53% on the -900. “We understand carbon better every day,” Lucas says. Door surroundings are now made of such materials, as is the pylon's upper spar. Those modifications will eventually be implemented on the -400.

In the cockpit, an “emergency automated descent” system has been created to prevent an accident in case the pilots do not identify a depressurization and faint. If the system detects a simultaneous cabin-pressure drop and crew inactivity, it will start a fast descent to an altitude where the pilots can breathe normally. It was designed to avoid a crash such as the fatal one of Helios Airways Flight 522 in 2005, when the crew of a Cyprus-registered Boeing 737 became incapacitated, leaving the aircraft on autopilot until it ran out of fuel. The system is planned to be implemented on the -400 as well.

Describing all these enhancements, Airbus officials say the A350, as a clean-sheet design, has a huge potential for optimization. In contrast, they insist the 777X is the last possible evolution of a relatively old type. Should airlines remain unconvinced, Airbus will essentially leave the large-widebody segment (from 350 seats) to its rival.

Although the 777-9X will be larger—by about 35 passenger seats—Airbus remains convinced the market for a further stretch would be too small. “The -900 and -1000 are where we see the bulk of the market,” Lucas says.

Technically, designing an A350-2000 would be straightforward, according to Evrard and Bregier. New engines may improve the business case. “When a new generation of engines appears, it will be time to rethink all that,” Bregier hints. For now, he suggests “a bit more seats” could be squeezed into the -1000, bringing it closer to the 777-9X’s capacity.

From a passenger perspective, the A350-1000 delivery flight from Toulouse to Doha, Qatar, was similar to the experience with the smaller variant. This included the silence of the cabin, fresh air conditions and even more powerful engines at takeoff. However, cabin crews should be advised to reduce noise in the galley. Because the aircraft is so quiet, passengers in the first row will notice galley noise. At a glance, the aircraft meets passenger expectations.

Planners Envision Aviation IP Network

INNOVA PROJECT HAS BEEN UNDERWAY FOR MORE THAN A YEAR

AVIATION IP NETWORK WOULD USE LATEST IPv6 ADDRESSING

Bill Carey Washington

Experts are planning an internet protocol (IP)-based aviation communications network that would be interoperable across air and ground domains, carriers and nations, with the International Civil Aviation Organization (ICAO) providing governance of a “trust framework” that authenticates system users.

The so-called Innova concept envisions a members-only IP network using the latest IPv6 addressing to succeed the current IPv4 addressing scheme. Network access would be secured by a federated trust system, with ICAO serving as a “bridge” linking various authorities that issue digital certificates to users as part of a public-key infrastructure (PKI). A PKI allows participating computers, people or organizations to securely communicate on a public network.

“IHO will play a fairly traditional role in terms of standardizing, permissioning, auditing and so on, while the bridge itself will probably be hosted by a private entity that other authorities would request to become trusted by,” Rob Segers, an FAA information security systems engineer, told a February gathering of the Royal Aeronautical Society in Washington. “This is a fairly standard way of doing things, but it does require an organization like ICAO to step up so it can be done at a global level.”

Trust is also a political challenge, Segers said. “Different countries may have different approaches to how they secure their information and what encryption level they want to apply and how they want to apply it. Now they have to accept that whatever method they use to encrypt their information is being trusted by other countries to be able to decrypt so that they can communicate with each other.”

Segers was among planners who described the initiative at the Washington event, as well as during the Global Air Navigation Industry Symposium held in Montreal in December. Plans call for submitting a proposal in October at the 18th Air Navigation Conference, a formal ICAO meeting with the theme “From Development to Implementation.”
Recommendations agreed on at that meeting will be submitted for approval to the organization’s governing council.

ICAO convened an Innova task force, which held its first meeting by teleconference in January 2017, according to observers representing the International Coordinating Council of Aerospace Industries Associations. The goals of the task force are to facilitate establishment of a “global interoperable IP closed network” by obtaining a generic top-level domain label—such as .com or .org—from the Internet Corporation for Assigned Names and Numbers (ICANN); making available IPv6 addresses; providing the services of a PKI to communicate over the network; and developing standards and recommended practices for IP-based communication.

“A lot of it is not new, although it may be new to some of the communications within the aviation world,” said Segers. “When you look at the public key infrastructure standards, the X.509 [digital] certificates, the use of certificate authorities for distribution of certificates—all those technologies are not leading edge; they have been standardized for a long time. The approach that we’re taking within ICAO is not to reinvent that wheel, but to use those technologies and those standards and to apply them in a way that can be acceptable to the global community.”

Planners speak of involving the entire aviation “ecosystem” of aircraft, systems, carriers, air navigation service providers and new airspace entrants such as drones and space vehicles, potentially amounting to billions of entities requiring internet addresses. There is a time driver to creating that network—the pool of unique IPv4 addresses is exhausted, and ICAO would have to make a formal approach to ICANN to obtain its own top-level domain for IPv6 addresses.

To lessen the impact on existing equipment and infrastructure, the concept envisions a migration process for legacy IPv4-based or non-IP-based systems: for example, by using an interface device that would accommodate a parallel data path over the IPv6 network.

While creating such an all-encompassing aviation network appears ambitious, a presenter at the Montreal conference suggested it can be achieved. “[W]hat we have done over the past few months is come up with a conceptual architecture that would span borders without boundaries,” said Terry Davis, chief scientist and founder of cybersecurity firm AtfCyber. “We will tie air-to-ground and ground-to-ground systems into a single architecture. And it [turns] out to be surprisingly straightforward. Amazingly, it is relatively lightweight in cost and complexity. It proves a point that we can at least go forward with this work.”

Also presenting at the December conference was Segers, who described an architecture approach to network governance that would see ICAO serving as a bridge authority to cross-certify different digital certificating authorities, ensuring interoperability and trust between regions.

In place of airborne systems decrypting and validating public-key certificates, Segers proposed using a “certificate validation server” that draws from network resources on the ground. “The certificate validation server is really the solution for the limitation of the air-ground bandwidth and avionics compute overhead, in order to make this operationally feasible,” he asserted.

As a trust bridge, ICAO would cross-certify digital certificate-issuing entities across regions.

Architecture Approach: ICAO “Trust” Bridge

Source: ICAO
Japanese Low-Cost Carriers Plan Next Wave of Growth

Japan’s low-cost carrier (LCC) sector has become a new battleground for local and overseas airline groups, and competition is set to increase further as LCC affiliates grow their narrowbody fleets and target more distant markets.

Most of Japan’s true LCCs are backed by some of the largest players in the Asia-Pacific airline industry. Peach and Vanilla Air are both subsidiaries of All Nippon Airways (ANA), Jetstar Japan is a joint venture between Japan Airlines and the Qantas Group, and newcomer AirAsia Japan is part of the AirAsia empire. The parent companies view the LCCs as vital to finding new customers in the lucrative Japanese market.

The ANA Group has recently laid out ambitious plans for Peach and Vanilla Air in its medium-term management road map. The group intends to increase the combined LCC fleet by 20 aircraft to a total of about 55 by 2022, which will help achieve its aim of doubling revenue from the LCCs.

Peach and Vanilla predominantly serve domestic and short-haul international flights with their Airbus A320 fleet. However, a key part of the group’s LCC strategy is to branch into longer flights to reach more Asia-Pacific markets.

Parent ANA Holdings plans to offer medium-haul LCC flights starting around 2020. An ANA spokeswoman confirmed that this will be done through Vanilla and Peach rather than a new subsidiary unit.

ANA says it is looking to add “small-size medium-haul aircraft” to operate the new routes and is still discussing what types it will choose. The aircraft selected will not be sourced from the group’s existing orders for Airbus narrowbodies.

ANA CEO Yuji Hirako has previously indicated that the carrier is considering transferring some Boeing 767s from its full-service operation to the LCCs. He stressed that this is only one option under discussion, however.

The medium-haul LCC operation will start with flights of 7.5-8 hr, the ANA spokeswoman says. It would then aim for flights up to 9 hr. A map released by ANA indicates that mainland China, all of Southeast Asia and parts of India will be the target areas for the medium-haul services.

Vanilla Air’s current international flights are to Taiwan; Hong Kong; Ho Chi Minh City, Vietnam; and Philippine destination Cebu. The longest route is to Ho Chi Minh City via Taipei, Taiwan, but the airline plans to suspend the Ho Chi Minh City leg from March 25.

Vanilla operates 14 A320s and has two more on order. One is due in the fiscal year ending March 31 and the other in the following fiscal year.

Peach flies 14 domestic and 14 international routes. Its international services are mainly to South Korea and Taiwan, with longer routes to Bangkok, Hong Kong and Shanghai. The airline operates 20 A320s and is due to add three more in the next fiscal year beginning April 1. Peach also has 10 A320neos on order.

The carriers are based at different hubs—Tokyo Narita International Airport for Vanilla and Osaka Kansai International for Peach. ANA Holdings has stressed that while the two LCCs

Low-cost carrier Peach is due to add more Airbus A320ceos to its fleet in 2018, with deliveries of A320neos to begin the following year.

will strengthen their relationship with each other, they will still operate independent businesses.

Rival Jetstar Japan also intends to boost its fleet over the next few years, following a recent growth hiatus. The carrier has added only one A320 in the past three years and now operates a fleet of 21.

Jetstar Japan plans to introduce three A320s in 2018. The carrier expects its fleet to increase by four in 2019, giving it a total of 28 A320s.

This represents a significant change in momentum for the airline. The last time Jetstar Japan received an aircraft was in March 2017, and prior to that its fleet size had remained unchanged since December 2014.

For the upcoming Northern Hemisphere summer season, the LCC will fly 12 domestic routes as well as international services to Hong Kong; Manila, Philippines; Shanghai and Taipei. This is an increase of one route for both the domestic and international networks compared to summer 2017. The airline added a flight from Tokyo Narita to Shanghai Pudong International Airport in June 2017 and a domestic route from Narita to Miyazaki in December. Jetstar Japan does not yet have any plans to add more international destinations, a spokesman says.

New entrant AirAsia Japan is much smaller but could eventually become a significant factor in the local LCC market. The carrier was launched in October as a joint venture between Malaysia-based AirAsia Group and Japanese partners.

AirAsia Japan has two A320s and operates a single domestic route between its Nagoya hub and Sapporo. The airline has no immediate plans for fleet growth and will instead look to increase utilization of its current aircraft. AirAsia Japan has previously said it wants to branch out to international service by targeting Taipei as its next destination, although there is no time line for such a move.

Adrian Schofield  Auckland

*AviationWeek.com/awst*
First results from crucial tests of two key elements of Rolls-Royce’s future large civil engine strategy—a new core and a high-power gear system—are positive and on track, says the manufacturer.

Providing details of the first test runs of the Advance3 high-pressure core at the heart of the company’s UltraFan concept, Phil Curnock, chief engineer for civil aerospace future programs, says, “We have done a significant amount of testing, and all technologies are performing well.”

The core is the common element of the company’s plan to succeed the long-running Trent family with a new gear-driven engine architecture from the 2020s. The new core, which began tests in November in a hybrid demonstrator, will be used initially in the Advance, a direct-drive turbofan with a fuel-burn at least 20% lower than the current Trent 700. And the Advance is a steppingstone to the UltraFan, a very-high-bypass design that marries the same core to a large gear-driven fan to improve fuel burn by at least another 5%.

“The UltraFan, which we hope will enter service in the 2025-27 timeframe, will be sold to airlines for 15-20 years and remain in service for probably 40 years,” says Rolls-Royce Chief Technology Officer Paul Stein. “The UltraFan at present is a demonstrator of all the new technologies, and we plan on launching it as a product in a few years’ time.”

Stein says aircraft manufacturers continue to be briefed about the Advance and its UltraFan follow-on. “Each of them may or may not modify their airframe plans as a result of having this technology available,” he adds. “It is such a step change in fuel burn that it is starting to make them sit up and take notice of what sort of efficient aircraft could come about if a modern aircraft design was coupled with the UltraFan itself. In our view, it is going to drive change in the market.”

In the Advance3 demonstrator, the core is sandwiched between the conventional fan system of a Trent XWB-84 Airbus A350 engine and the low-pressure turbine of a Trent 1000 Boeing 787 engine. “We are in Phase 1 of testing, and it is progressing extremely well,” says Curnock. Tests have reached the point where the P30 pressure (at the rear of the high-pressure compressor) has “got to 450 psi,” he says. “That means we have got to about 90% of core power.”

Initial tests of two technologies for Rolls-Royce’s future UltraFan engine have so far produced positive results.

Key tests include measurements of the bearing loads to assess the impact of Rolls’ design decision to place more work on the high-pressure spool and reduce the load on the intermediate compressor; “When you change the work split between the compressors, it gives different axial forces to the bearings, so we need to manage and monitor that,” says Curnock.

Tests of the core’s lean-burn combustor, which is also a new design to reduce emissions and boost efficiency, have also been positive, with no signs of an aero-acoustic effect known as a “rumble” that can sometimes occur with these designs. “We haven’t seen any rumble at all,” says Curnock, who adds that tests for other typical lean-burn-related concerns such as starting issues and fuel scheduling have “gone really well.”

Rolls-Royce has also begun tests of the third UltraFan power gearbox at its Dahlewitz facility in Germany. Evaluation of the 1-m-dia. (3.2-ft.) unit follows the news in September 2017 that the first PGB had been tested at its maximum rating of 70,000 hp. This is designed to enable the gear to be mated with the Advance3 demonstrator, which is aimed at the 70,000-80,000-lb.-thrust bracket.

Further components of the future family are being tested in focused demonstrators, including ALECSys (Advanced Low-Emissions Combustion System) and ALPS (Advanced Low-Pressure System), the first Rolls engine to combine a composite fan and composite fan case.
Rolls-Royce Doubles Down on Digital Strategy for Engines

> INITIATIVE BUILDS ON RECENT LAUNCH OF ROLLS’ R2 DATA LABS
> STRATEGY UNDERPINNED BY DIGITAL PLATFORMS DEVELOPED BY MICROSOFT AND TATA

Guy Norris Singapore

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Although marked in the physical world by the debut of the Trent XWB97-powered Airbus A350-1000, Rolls-Royce also chose the recent Singapore Airshow to highlight the launch of IntelligentEngine, an all-embracing digital strategy that the company says represents a paradigm shift in the way it designs, produces and supports propulsion systems.

While elements of that strategy have been emerging for several years as engines have become smarter and services more data-driven, Rolls-Royce says leaps in processing power, data analytics, connectivity and cloud computing have enabled a step change in the way digital technology can affect the entire engine enterprise. “We almost see it as being as big a shift as going from piston to gas turbine. It’s almost a new way of thinking,” says Rolls-Royce Senior Vice President of Marketing Richard Goodhead.

Rolls has seen the digital footprint of each successive engine generation increase with the use of computerized design systems and growth in operating and performance data. In addition, data from manufacturing and suppliers has increased as the services side of the engine-support business has flourished. With the growth of digital capability, Rolls sees an opportunity to make the whole greater than the sum of the parts. “It is a confluence of products, services and digital coming together—so in the future they will be inextricably linked,” says Goodhead.

The IntelligentEngine initiative builds on recently established links between Rolls and tech companies such as Microsoft and Tata Consultancy Services (TCS) that enable the manufacturer to “supercharge the overlap of products and service,” he says. Rolls and Microsoft agreed in 2016 to integrate advanced analytics into the engine-maker’s TotalCare services system based on Microsoft’s Azure cloud platform. Rolls took a further step toward the IntelligentEngine concept in June 2017 when it opened the Derby, England-based Airline Aircraft Availability Centre as a digitally enabled hub for engine operations, maintenance and management.

The center’s value has become widely apparent to Rolls in recent months, as the company tackles the widespread replacement on the Trent 1000 fleet of prematurely corroded intermediate-pressure turbine blades. Although Rolls acknowledges the issue has been more disruptive than it hoped, Goodhead says the ability to accurately model and predict corrosion rates and the remaining service life of blades has helped minimize downtime in most cases. “In the old world, we would have just had to take the engine off wing. If ever a cloud had a silver lining, it has allowed us to say this is the kind of thing we can do with this technology,” he says.

In December, Rolls also launched the R2 Data Labs organization aimed at using advanced data analytics, industrial artificial intelligence and machine-learning techniques to develop new design, manufacturing and operational efficiencies. Based on a series of data-innovation cells housing teams of experts, the R2 Data Lab builds on a digital platform developed in partnership with TCS. Complementary to the Microsoft system, Rolls says the Tata platform enables data to be captured, shared and analyzed more easily across the entire company.

Rolls-Royce’s IntelligentEngine plan embraces its entire enterprise, from servicing and building current engines to eventually, it hopes, closely integrating future propulsion systems and airframes like this hybrid-electric airliner concept.

“We are moving toward a world where engines will be connected [to Rolls and the airline infrastructure] and are contextually aware,” says Goodhead. “In the past, we would have known what was happening inside the engine, but with the advent of all this data we can access, we know much more about where the engine is going and how it is being used. That provides insights into how we can optimize the efficiency, durability and availability of the engine.

“The engine is also becoming much more self-aware through artificial intelligence and machine-learning. Ultimately, we could see examples of where it has diagnosed an issue and is able to fix itself, perhaps through smart snake robots or a swarm of robots—that’s the pinnacle,” he says.

Beyond the engine, Rolls also expects the initiative to play a greater role in designing more integrated airframe-engine combinations as the industry moves toward turboelectric and hybrid propulsion systems. The Rolls initiative comes as archivials General Electric and Pratt & Whitney make similar moves. GE, along with its CFM joint venture with Safran, is developing the “digital twin” concept to reduce unplanned engine downtime.

The initiative is part of GE’s drive to become a digital manufacturing company and builds on its Predix software platform for the Industrial Internet. Pratt & Whitney, currently introducing its PW1000G geared-turbofan family, has introduced the eFAST data ecosystem to reduce operational disruptions and increase utilization. Pratt parent company United Technologies Corp. is investing $900 million in its Digital Accelerator business. ©
Pratt Fast-Tracks GTF Fix

> FINAL MODS INTRODUCED INTO PRODUCTION PW1100G ENGINES
> PRATT PROMISES AIRBUS REVISED STANDARD DELIVERIES IN MARCH

Jens Flottau Toulouse and Guy Norris Los Angeles

Pratt & Whitney is accelerating the introduction of a modified PW1100G high-pressure compressor seal based on an earlier production standard as part of plans to supply delivery-compliant engines to Airbus as soon as early March.

The configuration change, the latest twist in the long-running saga of its embattled PW1100G geared turbofan, follows a series of failures that prompted the grounding of some A320neos and Airbus’ February suspension of deliveries. The revisions should enable those to restart in April—and come just as Pratt resolves longer-term reliability problems with the No. 3 bearing seal and combustor that have dogged the A320neo engine program since 2015.

Pratt says the revised configuration to the knife-edge seal at the aft hub of the high-pressure compressor (HPC) is “based on a design with which the company has significant experience, and this solution has received all necessary regulatory approvals.” Additional details have not yet been released, though a Pratt spokeswoman says that while the design is based on the prior configuration, “it is not technically right to say we are going back fully to the prior configuration.”

Problems with the seal, which was introduced into new production engines in mid-2017 to improve durability, emerged in January within weeks of entry into service on the latest A320neo deliveries the previous month. Fractures in the HPC seal caused four instances in which engines suffered high rotor vibration and stallings; two resulted in inflight shutdowns, two in rejected takeoffs. The incidents led Pratt and Airbus to issue urgent recommendations to A320neo operators to ensure aircraft have no more than one affected engine installed and to ban ETOPS flights.

By the time the problem became apparent, Pratt had delivered about 100 engines to Airbus with the new seal configuration, 55 of which were at final assembly lines and 43 of which had entered service on 32 aircraft, starting in December. According to the European Aviation Safety Agency, 11 of those 32 were scheduled to be grounded after three more sectors, while 21 have only one of the affected engines installed.

Airbus CEO Tom Enders says the latest issue means “more work, stress and strain and more disruptions for our customers.” However, he cautions that the impact on 2018 Airbus deliveries is unclear and may be smaller than many expect. “Look at what our teams have done in the past year,” he says, referring to earlier changes to the engine and the recovery effort. Enders also says Pratt is “not alone” in causing delays. “CFM is behind in [engine] deliveries to us, and that is something that needs to be corrected.” But he adds he has “commitment from the top leadership at GE and Safran that they will do everything they can to fix this.”

Airbus expects to deliver about 600 single-aisle aircraft in 2018, some 400 of which are planned to be A320neos and A321neos. The 400 are split roughly between the CFM and Pratt variants.

Pratt says all new engines are now being delivered with the revised bearing seal and combustor. Changes are being implemented in A320neo PW1100G and Bombardier C Series PW1500G engines as they come back in for overhaul and modification.

The chief change to the bearing housing is a switch from the lift-off seal used in the original design to a dry face seal, now the standard configuration. The dry-running face seal consists of a rotating mating ring made from a carbide material and a carbon-graphite stationary ring. The faces are flat and held together tightly using magnets or springs to prevent oil leaking through despite the high revolutions. The lift-off seal, on the other hand, incorporates grooves and wedges to channel a thin film of air between the sliding seal faces, which creates aerodynamic lift.

The revised combustor configuration is designed to address the durability problems that led to a rash of premature engine removals by two Indian-based A320neo operators, GoAir and IndiGo. “We have roughly doubled the number of air-cooling holes and configured the density of the holes to the lower left of [the] intake/outtake valve. We essentially had the density in the wrong place originally,” says the engine-maker. The revised design is expected to increase durability by a factor of five over the baseline.

Pratt says it remains on track to almost double production in 2018 from last year’s 374 engines. “Our facilities are ramping up for new production as well as overhaul capability, which last year we matured faster than we had expected,” says Pratt, which expects to be under significant pressure throughout the year: “There is still a population of engines that will have to go through overhaul again.”
Europe Eyes Fuel-Saving Boundary-Layer Propulsion

> MECHANICALLY DRIVEN FUSELAGE FAN COULD REDUCE FUEL BURN

> TURBOELECTRIC CONFIGURATION WILL BE EVALUATED UNDER CENTRELINE PROGRAM

Graham Warwick Orlando, Florida

Airlines with fans embedded in the tail to reenergize the fuselage wake and reduce drag are attracting interest as a potential next step in cutting the fuel burn of commercial aircraft. But there is debate over whether such designs are also a promising initial application of electric propulsion to large aircraft.

NASA’s single-aisle turboelectric aircraft with aft boundary-layer propulsion concept, or STARC-ABL, is drawing attention thanks to studies indicating a 7-12% reduction in fuel burn in a configuration that is otherwise similar to conventional airliners flying today.

The improvement is achieved by ingesting and accelerating the slow-moving fuselage boundary layer using an electrically driven fan mounted on the tail. This fills in the wake and reduces drag. In STARC-ABL, the tail fan is powered electrically by generators on the underlying engines, which can be smaller than in a conventional airliner because of the reduction in drag.

But there are other ways of achieving boundary-layer ingestion (BLI). Aurora Flight Sciences’ D8 design has its turbofans embedded between the twin tails, where they ingest the flow over the upper fuselage. French research agency ONERA’s Nova concept is essentially similar, but with the engines embedded in the aft fuselage on either side of the single tail.

Bauhaus Luftfahrt’s Propulsive Fuselage Concept (PFC) is similar to STARC-ABL in that the propulsor is mounted on the tail, breathing through an annular inlet that runs round the aft fuselage. But where the NASA concept is turboelectric, this uses another gas turbine in the aft fuselage to mechanically drive the BLI fan.

Bauhaus, a research institute in which Airbus is a shareholder, developed the concept under an EU-funded project, Dispersral, completed in January 2015. This study indicated a fuel-burn reduction of 9-14% compared with an equivalent to a 2035 entry-into-service conventional single-aisle airliner.

Since completing Dispersral, Bauhaus has continued to refine the concept, conducting a more detailed analysis comparing a conventional 340-seat, 4,800-nm-range widebody twin to a PFC aircraft with a tail-mounted, turbine-driven fuselage fan for wake-filling and underwing geared turbofans for residual propulsion.

A two-shaft turbine engine is installed in the aft fuselage, the low-pressure spool powering the fuselage fan via a planetary reduction gear system. Air enters the fan via a 0.54-m-high (1.8-ft.) annular intake duct. The fuselage boundary layer is about 1 m deep at this point, says Bauhaus. Inside the nacelle, aft of the fan, an S-duct supplies air to the core engine.

Results of the study were presented at the American Institute of Aeronautics and Astronautics (AIAA) SciTech conference in January. Bauhaus reported a 12.1% reduction in fuel burn over the advanced, 2035-time-frame conventional design. Aircraft empty weight increases by 4.6% because of a 16% higher propulsion system weight due to the fuselage fan, but maximum takeoff weight is essentially unchanged.

For the baseline study, Bauhaus assumed a common core is used in the fuselage fan and underwing engines to minimize cost. Removing this constraint and individually optimizing the size and thrust split between the fuselage and underwing propulsion systems resulted in a further 1.3% reduction in block fuel.

Where the conventional reference aircraft requires a maximum climb thrust of 12,880 lb. per engine, this was reduced to 8,450 lb. in PFC, the fuselage fan producing a net thrust of 3,690 lb. When the common-core requirement is removed, the fuselage fan shrinks to 2,610 lb. thrust while the underwing engines grow to 8,880 lb., but block fuel burn reduces by 13.1% compared with the reference aircraft.

Future work will look at optimizing the engine cycles for the PFC. Bauhaus is leading the follow-on to Dispersral, a three-year, £3.68 million ($4.52 million) project called Centreline funded under the EU’s Horizon 2020 research program. Launched in June 2017, Centreline will conduct scaled wind-tunnel tests, high-fidelity numerical simu-
The era of large defense budgets is back, with the Pentagon unveiling an ambitious spending plan that seeks to pivot from the counterterrorism operations that have shaped the last decade to the great-power conflicts that will define the future.

A two-year budget agreement paves the way for lawmakers to fund defense at $700 billion in fiscal 2018 and $716 billion in fiscal 2019, and hopefully avoid devastating budget gridlock next year. In fiscal 2018 alone, this is an 11% increase over fiscal 2017, and a 20% increase over the post-sequestration low in fiscal 2015.

The Pentagon is taking advantage of the windfall to invest in emerging technologies, such as hypersonics and swarming drones, to counter the evolving threat from potential adversaries such as Russia and China. But the department is also putting cash toward much-needed modernization across the board, including its fighter fleet and the nuclear triad, and critical maintenance of aging equipment.

“Great-power competition, not terrorism, has emerged as the central challenge to U.S. security and prosperity,” Undersecretary of Defense (Comptroller) David Norquist said Feb. 12 during the budget rollout. “Our nation’s strategy seeks areas of cooperation with competitors from a position of strength. But we recognize that, if unaddressed, the eroding U.S. military advantage versus China and Russia could undermine our ability to deter aggression and coercion in key strategic regions." As a result, programs across the board are in line for a cash infusion. Some of the biggest winners include:

The Navy took advantage of the defense windfall to boost its aviation accounts, asking for 120 new aircraft this year alone. The seafaring service has made it clear they want more F/A-18E/F Super Hornets—a lot more. Reversing the previous administration's plan to phase out the Boeing fighter in favor of the F-35C, the Navy is now planning to buy 110 additional Super Hornets over the next five years. Congress could intercede, however, if the Navy does not make progress getting to the root of a spike in hypoxialike physiological events across the existing fleet that may indicate a problem with the design of the oxygen system. Other big-ticket items on the Navy's to-buy list this year include Boeing P-8s, Sikorsky CH-53Ks and Bell-Boeing V-22s.

The Air Force's research and development budget is set to explode in fiscal 2019, eclipsing even the requested procurement funding. Some of the money will go toward big-ticket modernization items, such as the B-21 bomber and the Next-Generation Air Dominance family of systems, which could include a next-generation fighter to replace the F-35, Lockheed's F-22 air superiority fighter, or both. But with China emerging as the Air Force's primary competitor, it will also be used to develop "game-changing technologies," such as hypersonic aircraft and missiles, directed energy, unmanned autonomous platforms, artificial intelligence and nanotechnology.

Lifting the budget caps means Christmas has come early for defense contractors, with the Pentagon able to put billions more dollars toward buying weapons, sustaining the ones they already own and investing in new technology. Boeing is a big winner, with a potential multiyear deal on the horizon that could keep the Super Hornet production line hot for years to come, and a pledge by the Air Force and Navy to buy an eye-popping 43,594 Joint Direct Attack Munitions in fiscal 2019.

Raytheon and Lockheed Martin will also cash in on the Pentagon's plan to spend $20.7 billion on missile programs this year alone. Lockheed and Boeing will also benefit from increased spending on missile defense in light of recent aggression by North Korea. But most important, the two-year deal will finally give defense contractors and subcontractors the funding stability they need to be most productive.

On the heels of the Trump administration's unveiling of the Nuclear Posture Review, the fiscal 2019 budget boosts spending across the board for modernization of the U.S. nuclear triad: the Navy's new Columbia-class ballistic-missile submarine, the Air Force's B-21, the next-generation Ground-Based Strategic Deterrent, and the nuclear-tipped Long-Range Standoff Weapon (LRSO) that will arm the B-21 and B-52 bombers.

The Pentagon will also begin buying significant quantities of Boeing's precision-guided tail-kit assembly for the B61-12 nuclear bomb that will arm nuclear-certified U.S. and NATO aircraft such as the F-35. But notably absent from the Pentagon's budget rollout on Feb. 12 were any details about the Trump administration's planned low-yield nuclear warhead for the submarine-launched Trident D5 fleet ballistic missile or the proposed sea-launched nuclear cruise missile.

As Russia and China invest in new missile capabilities and North Korea continues its aggressive push to develop nuclear weapons, the Trump administration's National Defense Strategy (NDS) calls for investment...
in missile defense. In addition to continuing to develop exquisite solutions to counter traditional ballistic missiles, such as next-generation radars, missiles and exoatmospheric kill vehicles, the Missile Defense Agency proposes spending about $780 million in fiscal 2019 to ramp up experimentation with drone-borne sensors and laser weapon technologies to foil potential adversaries’ pursuit of asymmetric threats.

The Vietnam-era B-52, fielded in the early 1960s, will continue to fly even after the much newer Rockwell B-1B and Northrop Grumman B-2 are gone, according to the Air Force’s new bomber road map. Eventually, the service’s entire bomber fleet will be made up of the venerable “BUFF” and an aircraft almost 100 years younger—the next-generation B-21.

The Air Force has already spent more than half a century installing various avionics and weapon systems upgrades on the B-52, but the latest shift means a plan to replace its eight original Pratt & Whitney TF33-103 turbofan engines will move forward full-steam, adding range, reducing fuel burn and boosting power generation. It also ensures the future of the LRSO, as the B-52 will need a next-generation standoff weapon to keep pace with the threat well into the century.

As the threat evolves across all domains, the NDS also highlights the importance of staying in front of technology changes. To maintain the U.S. military’s edge, the Pentagon is investing in emerging technology: hypersonics, including high-speed strike weapons; autonomy, such as swarming drones; cyber-integrated defenses; space resilience; electronic warfare; artificial intelligence; and directed energy.

The Navy in particular is putting money toward developing high-energy lasers, asking for $299 million for the Navy Laser Family of Systems, a
rapid prototyping effort that aims to provide near-term ship-based laser weapon capabilities. The service plans to develop and install a number of prototypes in fiscal 2019. Meanwhile, the Air Force is continuing its investment in fielding a high-energy laser on a fighter.

**The Pentagon’s investment in space, particularly defense of space assets, also spiked,** with the Air Force’s space account getting a 9% increase. Officials say this budget marks a turning point in military space programs, as adversaries such as Russia and China build capabilities that can threaten U.S. access and freedom to operate in space. In particular, the U.S. is shifting its strategy for the future of its most advanced nuclear missile-warning satellites, canceling the purchase of the Space-Based Infrared Satellites (SBIRS) 7 and 8 and instead moving to develop an “evolved SBIRS” or E-SBIRS and a Next-Generation Overhead Persistent Infrared system.

**The Air Force and Navy are committed to sustaining their fourth-generation fighters,** with both services increasing funding for aviation readiness through their operations and maintenance accounts. Meanwhile, both are investing in modernization as well. The Navy is continuing an effort to extend the life of its legacy McDonnell Douglas F/A-18A-D Hornets, including an airframe extension, new conformal fuel tanks to extend range, a more powerful computer and advanced cockpit displays. The Air Force, after floating the possibility of retiring its McDonnell Douglas F-15C/D Eagles in favor of upgraded General Dynamics F-16s, is now investing millions to upgrade all of its legacy fleets: the F-15s, F-16s and A-10 Warthogs.

President Donald Trump promised a significant funding hike for the military on the campaign trail, and he has finally delivered with a deal that is more than the Pentagon dared hope for just months ago. The two-year plan he signed Feb. 9 has prompted applause from Republican lawmakers and will play well with Trump’s base. It shows the administration is taking seriously the emerging threats from potential adversaries such as Russia, China, North Korea and Iran, and the need to maintain the health of U.S. forces. But the buildup may be short-lived, some analysts caution, as the spike in federal spending, combined with Trump’s recent tax cut, will cause the deficit to skyrocket.

**Most accounts received a boost in funding, but not all programs were left standing. The Air Force’s plans to kill an effort to replace the aging Northrop Grumman E-8C Joint Surveillance Target Attack Radar System surveillance and battle management fleet with a similar platform, and phase out the Rockwell B-1B and Northrop Grumman B-2 bombers as the next-generation B-21 comes online, are part of a broader move to streamline and evolve in a changing threat environment. But Trump’s decision to cut purchases of Lockheed Martin’s F-35 in the short-term compared to those planned by the previous administration leaves some observers scratching their heads.**

**The Air Force will attempt to kill an ongoing program to replace the aging Northrop Grumman E-8C Joint Stars surveillance and battle management fleet with a similar platform—if Congress allows it. Instead, the service wants to eventually transition to a next-generation “advanced battle management system,” but so far that capability remains undefined. To fill any gaps in the meantime, the Air Force will modernize seven of its Boeing E-3 Airborne Warning Command and Control aircraft with improved cockpit and navigation systems and keep the current J-Stars operational through the mid-2020s. Although the service hopes there will be no impact to the mission, the three industry teams that have spent the last few years developing prototypes for the J-Stars recapitalization program will surely be disappointed.**

**With the defense spending windfall, many observers expected ramped-up purchases of Lockheed Martin’s F-35. But instead, the Pentagon has actually cut planned buys of the fighter in the short term compared to the previous administration’s road map. The decrease is not a huge reduction—329 F-35s from fiscal 2018-21 versus 341—but it is significant given the increase in defense funding. Until recently, Air Force and Marine Corps leaders repeatedly made the case to Congress that more F-35s, and faster, will allow them to rejuvenate aging fleets while bringing production costs down. Meanwhile, the Air Force is investing $9.89 billion over the next five years to develop an “integrated family of systems and technologies” to ensure air superiority well into the decade, which will likely include a next-generation fighter.**
MDA Advances Missile-Hunting UAV Programs

A s U.S. adversaries field more complex and deceptive missiles, high-flying UAVs armed with advanced sensors and laser weapons could hold the key to defeating them.

Instead of using Boeing 747 airliners to shoot down missiles with chemical lasers, the U.S. Missile Defense Agency (MDA) proposes employing high-altitude, long-endurance UAVs carrying modern diode-pumped alkali or beam-combining fiber lasers.

The agency also has proposed an upgrade kit for the General Atomics Aeronautical Systems (GA-ASI) MQ-9 Reaper that would allow the remotely piloted aircraft to detect and track missile threats as an airborne complement to ground-based missile defense radars.

The U.S. has spent hundreds of billions of dollars over decades developing exquisite radars, interceptors and exoatmospheric kill vehicles to take out traditional ballistic missiles. But North Korea’s and Iran’s pursuit of decoys, penetration aids and defensive countermeasures for their missile forces, as well as Russia’s and China’s introduction of more advanced hypersonic airbreathing and boost-glide vehicles, is undermining America’s investments.

To counter these evolving threats, over the next five years, MDA proposes spending about $780 million to ramp up experimentation with droneborne sensors and laser-weapons technologies. This level of funding pales in comparison to investments in next-generation radars, interceptors and kill vehicles, but it will validate new operational concepts for UAVs that could rapidly be fielded through partnerships with the military services, particularly the U.S. Air Force.

Today, the U.S. has very few options for taking out missiles in the boost phase, when they are moving slowest and hottest and have not yet deployed defensive aids. But the YAL-1 Airborne Laser Program in 2010 proved without a doubt that directed energy can efficiently and effectively shoot them down. Using a massive megawatt-class chemical laser, the 747 intercepted multiple Scuds.

Although the flying laser testbed was canceled in 2011, MDA’s interest in lasers for missile defense never really went away, it just transitioned to new types of lasers based on high-altitude unmanned platforms.

“The 747 Airborne Laser wasn’t a waste of money at all; it advanced some optics and beam-control capabilities that make the current program possible today,” says Thomas Karako of the Center for Strategic and International Studies.

“We’d be further along today if that program had been prudently adjusted rather than canceled. We lost years.”

Karako says the 747 had obvious operational limitations, but he encourages MDA to “stay the course” with its transition to unmanned platforms and solid-state laser weapons, and not get distracted by “every shiny object.” He says putting new types of sensors on UAVs and space-based platforms also will help fill the U.S. government’s “midcourse gap” in the birth-to-death tracking of missile threats.

On Feb. 12, MDA Operations Director Gary Pennett confirmed during the agency’s fiscal 2019 budget rollout...
that interest in high-altitude UAVs for finding, fixing and defeating missiles remains high, and funding has been earmarked for continued experimentation.

He says the MDA is moving forward with preparations for a droneborne laser experiment, with flight-testing expected to get underway in the 2022-23 time frame. The agency’s budget line for “technology maturation initiatives” supports two main UAV-based efforts, one for scaling up lasers and another for discriminating sensors. Pennett says $149 million has been requested for these efforts in 2019, of which $61 million advances the agency’s Low-Power Laser Demonstrator (LPLD) program and $79 million funds Discrimination Sensor Demonstrator Development.

LPLD carries forward the work pioneered by the YAL-1 program, except on a high-altitude unmanned aircraft, although the government has not ruled out using a manned surrogate. If fielded, the platform certainly would be remotely operated to increase loiter time and reduce the cost of maintaining 24/7 orbits.

Last year, the MDA awarded contracts to Boeing, Lockheed Martin and General Atomics to develop competing proposals. Later this year, the agency will select one of those proposals to carry forward into initial design. By next year, the MDA expects to have a system-level blueprint ready for construction.

The MDA has been working with two federally funded research facilities on high-power laser architectures that could be scaled up to defeat missiles. The Lawrence Livermore National Laboratory has been developing a next-generation diode-pumped alkali laser, while the MIT Lincoln Laboratory works on a beam-combining fiber laser.

According to the agency’s budget documents, flight-testing of the preferred high-altitude drone is set to begin in 2022. Flight experiments would take place in 2023, starting with target-acquisition and tracking-discrimination trials, followed by beam-control-and-stability and eventually high-power laser testing. The MDA has earmarked $331 million for these laser experiments through 2023.

We have some idea about the performance specifications of the high-altitude test platform, thanks to a request for information issued last June. The testbed aircraft must fly above 63,000 ft. with an endurance of at least 36 hr. at cruise speeds of about Mach 0.45. It must have a payload capacity of 5,000–12,500 lb., produce 140–280 kW of power and support an optical sensor measuring 3.3–6.6 ft. (1–2 m).

Pennett says the MDA would not buy its own fleet of laser drones, but instead

Trump Budget Revives ATC Restructuring Plan

> BUDGET WOULD FUND FAA AT $16.1 BILLION, LESS THAN PREVIOUSLY

> FUNDING FOR NEXTGEN PORTFOLIO PROGRAMS FALLS BELOW $1 BILLION

Bill Carey  Washington

The Trump administration rolled out a fiscal 2019 federal budget on Feb. 12 that seeks $16.1 billion for the FAA, $292 million less than its previous appropriated level, while resuming the effort to break out the agency’s air traffic control (ATC) function into a separate entity.

The proposed budget seeks $952 million for the FAA’s NextGen program portfolio, which would drop the long-running ATC modernization effort below the billion-dollar annual spending level of the previous two years. While President Donald Trump denounced the ATC system last year as “ancient” and “broken,” budget documents assert the FAA “has made solid progress” by introducing technologies that have saved airspace users $2.72 billion in operating costs, with $13 billion in benefits expected by 2020.

Core programs are moving from development status into baseline and operational systems, including automatic dependent surveillance-broadcast (ADS-B), data communications (Data Comm), time-based flow management, terminal flight data manager and system-wide information management.

Using contractor Exelis (now Harris Corp.), the FAA finished installing the nationwide ADS-B ground infrastructure of 634 radio stations in 2014; civil and military aircraft must be equipped to interact with them by January 2020. As of 2016, the FAA had upgraded 55 airport towers for Data Comm, allowing controllers to send departure clearance instructions to pilots via text messages. Plans call for installing the capability at all 20 air route traffic control centers that manage high-altitude traffic between 2019-2021.

Nevertheless, Trump’s budget rekindles the so-called ATC reform effort the Republican-led House Transportation Committee initially advanced in 2016. Favored by major U.S. airlines represented by trade group Airlines for America (A4A), but opposed by non-A4A member Delta Air Lines and facing stiff resistance from Democrats and general aviation interests, the measure failed to come to a vote in either the full House or the Senate.

The budget contains a multiyear FAA reauthorization proposal to shift responsibility for ATC to a “nongovernmental, independent air traffic services cooperative.” While keeping in place the agency’s current financial and organizational structures, it lays the groundwork for seamless separation of “key FAA elements,” advises a budget document.

“While we have made progress, the time has come to embrace a bolder vision of what our nation’s air traffic control system can be and how best to move forward to achieve it,” the document states. “The FAA is funded almost entirely by the users of the national airspace system. This makes the president’s vision of a self-sustaining, nongovernmental, not-for-profit air traffic control entity achievable now.”
Below $1 billion “has made solid progress” by intro-

budget documents assert the FAA two years. While President Donald

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U.S. BUDGET

Restructuring Plan

Trump Budget Revives ATC

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Deep Space Gateway, a combination

(LEO) research outposts as well as

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President Donald Trump fol-

owed up his pledge to return U.S.

astronauts to the Moon with a $19.9 billion fiscal 2019 spend-

ing plan—a 2% increase over 2017 and 2018—that would wean NASA from
direct support of the International Space Station (ISS) by 2025 and bol-

ster public-private partnerships to develop alternative low-Earth-orbit
(LEO) research outposts as well as lunar landing and exploration tech-
nologies. 

At best, the U.S. toehold in lunar

orbit will not come until 2022, when the first element of the proposed
Deep Space Gateway, a combination research outpost and deep-space technology tested in cislunar orbit, is

launched aboard a commercial vehicle.

Previously, NASA planned to

launch the gateway’s building block—a power-and-propulsion module that de-

buts in the fiscal 2019 budget with an

1972 under the Apollo program.

Though the payload is bumped from the first crewed flight of the SLS-Ori-

on space transportation system, the

administration maintains full funding of $37 billion for the heavy-lift rocket,
capsule and ground support systems for fiscal 2019, which begins Oct. 1. An

unnamed debut flight of the SLS-Ori-

on is expected by June 2020. The rock-

et is not scheduled to fly again until its

mobile launcher platform is modified to handle an upgraded upper stage, work that will take an estimated 33

months.

The Trump administration pro-

poses cutting off direct NASA spend-

ing on the ISS in 2025 and shifting the agency onto lower-cost commer-

cial research stations and vehicles. The fiscal 2019 budget offers $150

million to kick-start a five-year $900 million effort called “Commercial

LEO Development” for public-pri-

vate partnerships intended to seed alternative space stations and/or

shift the ISS into commercial hands. The U.S. and its partners so far have

agreed to maintain the ISS through 2024, though the station, which has

been staffed by rotating crews of astron-

auts and cosmonauts since No-

vember 2000, is expected to remain structurally sound until at least 2028 and possibly much longer.


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2019 Spending Plan Shifts NASA

Toward Moon

FISCAL 2019 PLAN GETS $300 MILLION BOOST FROM CONGRESSIONAL BUDGET DEAL

DEBUT FLIGHT OF SLS-ORION SCHEDULED FOR JUNE 2020

Irene Klotz Cape Canaveral

The White House wants commercial ISS alternatives in place by 2025.

initial $328 million request—on the first crewed flight of the Space Launch System (SLS) rocket and Orion cap-

scale, currently targeted for 2023.

The NASA budget request, re-

leased on Feb. 12, made no mention of when U.S. astronauts would return to the lunar surface. NASA landed six

crews on the Moon between 1969 and

in 2023.

The Lawrence Livermore National Lab-

on high-power laser architectures that

are ready for construction.

Agency documents show significant flight testing with the MQ-9s taking place in the fiscal 2021 and 2022 time
frame, including a “launch-on-remote” test where an interceptor will be fired at a target based on targeting information
from the drone’s new sensors.

Riki Ellison, chairman and found-
er of the Missile Defense Advocacy

Alliance, says the fiscal 2029 budget submission does not hugely ramp up investment in these airborne sensor and

laser programs, but he expects greater investment to come in the 2020 budget plan.

“They need to put their best people on this technology and advocate for more investment to fully develop and

test it,” Ellison says. “It is the most challenging of all the missile defens-
es we are developing. It needs to be on the scale of their Redesigned Kill Vehicle and Multi-Object Kill Vehicle

investment.”

partner with the military services be-

cause its drones are test assets.

For sensor development, the agency

has budgeted $407 million through fis-
cal 2023, which funds ground, airborne and space-based testing of “tracking lasers, advanced detectors, infrared

sensors, and precision tracking and disrimination algorithms.”

For these experiments, the agency

has access to three General Atomics

UAVs: Two Block 1 MQ-9s and one ex-
tended-range Block 5 MQ-9 “Big Wing.”

The aircraft are contractor-owned and

operated, with the most noticeable modifications being forward-looking Raytheon Multispectral Targeting Sys-

tems (MTS). While past experiments have used two MQ-9s to stereoscopically detect targets, the agency is upgrading

the latest MTS-C sensor turret, which incorporates a tracking laser for single aircraft missions.

These medium-altitude aircraft,

when linked into the wider ballistic

missile defense architecture, would be

valuable airborne sensors that could

track conventional as well as maneu-

vering hypersonic threats, the MDA

says.

“MDA is partnering with the ser-

dvices to develop concepts for the
cost-effective integration of the sen-

tor technology into limited-fielding

upgrade kits,” the budget documents

state. “These kits could be installed

on MQ-9 aircraft deployed in-theater
to add missile defense capabilities on

short notice.”

A contracting notice issued in Sep-

tember says the MDA has been dis-

cussing with the U.S. Pacific Air Forces

the possibility of deploying these MQ-

9s to Japan’s Kadena Air Base “or an

alternate remote deployment location.”

However, probably due to regional sen-

sitivities, Pennett says the budget does

not support a deployment to Japan.
In fiscal 2017, the U.S. Agriculture Department spent $2.4 billion—56% of its budget—suppressing wildfires. And it is not just in the U.S. North of the border, in British Columbia, fires burned almost 3 million acres last year at a cost of $450 million. And by early September, forest fires had burned more than 1.8 million acres across the European Union, dramatically up from previous years.

Fueled by droughts and heat waves, these figures are records, or close, and one result is an increase in investment, or at least interest, in new firefighting aircraft—in a market that has largely made do with older equipment modified for the role.

Much of the renewed investment is focused on initial attack: knocking down the fire before it has a chance to spread. And the figures show why. The acreage burned in the U.S. in 2017 was the third highest on record, but the number of fires was the seventh lowest since 2000, says the National Oceanic and Atmospheric Administration. As a result, the acres burned per fire were the second highest on record—underlining the need to bolster initial attack.

Last year was worse, but it was the brutal 2016 fire season that prompted the Los Angeles County Fire Department to purchase two new Sikorsky S-70is for conversion to Firehawk firefighting and multimission helicopters. The aircraft were handed over in December. Once modified with belly tank, extended landing gear, medical interior and other mission equipment, the aircraft will enter service in 2018, joining three S-70A-based Firehawks operated since 2000 and 2005.

Also in December, the California Department of Forestry and Fire
North American sales. “Now we are seeing so much interest in the market it’s overwhelming.” With wild fire seasons increasing in length and ferocity, the manufacturer is responding to inquiries from fire departments “up and down the California coastline” as well as internationally, she says, about new-build fire fighting crews and converted ex-U.S. Army UH-60A Black Hawks.

The need for initial attack capability, and aircraft that can refill with water close by and reattack fires quickly and repeatedly, has also rekindled interest in the CL-415 amphibious water bomber, says British Columbia-based Viking Air. The company purchased the type certificates for the CL-215 and -415 from Bombardier in 2016. “We are seeing a lot of interest from legacy and new markets,” says Dominique Spragg, vice president of strategic planning.

Since acquiring the amphibious aircraft line from Bombardier, Viking has focused on improving support for the 190 aircraft in service. “All inventory and support has been set up in Calgary [Alberta] to support the worldwide fleet,” says Spragg. As a next step, the company is offering piston-powered CL-215s upgraded to CL-415EAF (for Enhanced Aerial Firefighter) standard with turboprop engines, increased-capacity water bombing system, updated avionics and other improvements. “We have 11 aircraft now in inventory,” he says. This could lead to a possible third step: launching production of an upgraded new-build aircraft.

New aircraft such as the Firehawk and CL-415 are expensive, but the market is looking for their greater capabilities. France’s Securite Civil has ordered six modified Bombardier Q400 water bombers from Canada’s Conair Group to replace its converted Grumman S-2 Trackers. Conair has purchased the six aircraft from Bombardier for $206 million. They will be converted to Q400MR multirole air tanker configuration, with an enhanced version of Conair’s 2,640-gal. retardant delivery system, and enter service alongside two Q400MRSs modified from used aircraft and delivered in 2009.

The Securite Civil also operates 12 CL-415s, but after a devastating 2017 fire season at least one region—Provence-Alpes-Cote d’Azur—says it is prepared to spend $25-30 million for its own water bomber if the national agency is unwilling to expand the fleet.

Because of their cost, new aircraft must be capable of multiple missions. “The Firehawk is an expensive aircraft, but very capable. To really leverage it, it has to do more than firefighting,” says Mike Slattery, president of United Rotorcraft, a subsidiary of air medical helicopter operator and modifier Air Methods. “It is designed not only for firefighting but also search and rescue, medical evacuation and transporting firefighting crews and cargo,” he says.

The interior is designed so the Firehawk can be switched between roles without removing or installing equipment. “Nothing leaves the aircraft,” says Slattery. To switch between fire-fighter transport and medevac, the seats for 12 crewmembers can be folded up into the ceiling in 120 sec. and two patient litters moved into position. This versatility means the helicopter can transport the fire crew to the scene, use its snorkel and belly tank to fight the fire, then pick up the team and return to base.

Demand for the Firehawk is being driven by longer, more intense fire seasons. “Initial attack aircraft are very important, to hit the fire before it grows,” says Spragg. The helicopter can drop 1,000 gal. of water versus the 500 gal. carried by the widely used Bell 212/412. The only aircraft that can put more water per hour on a fire, he says, are a large air tanker such as the McDonnell Douglas DC-10—“and that is not for initial attack”—and the Erickson Air Crane version of the Sikorsky S-64 Skycrane, which “carries more water, but is slower; The Firehawk is more effective at putting water on a fire.”

United Rotorcraft will be prime contractor for the Cal Fire order, which was held up by a protest from losing bidder Leonardo. The protest was denied in December, and Spragg expects a contract within weeks. “Sikorsky has aircraft on the line for Cal Fire, and first delivery is to be within 365 days [of contract award],” he says. “They plan to buy all 12 aircraft over the next three years.” San Diego, like Los Angeles County, will buy its aircraft from Sikorsky then contract separately for the completion.

The latest Firehawk is based on the S-70i produced in Poland by Sikorsky subsidiary PZL Mielec. Compared with the original S-70A, this has upgraded General Electric T700-701D turboshafts wide-chord rotor blades and Rockwell Collins integrated cockpit. Changes to the avionics are limited to
installing a more versatile intercom and tactical communications systems. The S-70i Firehawk will also have a new-technology belly tank, he says.

The starting point for Viking’s upgraded CL-415EAF waterbomber, meanwhile, is the CL-215T turboprop retrofit originally developed for the CL-215 but discontinued in favor of the new-build CL-415. Reengined with the same Pratt & Whitney Canada PW123AF turboprops, the CL-415EAF will have the CL-415’s increased, 1,620-gal. firebombing capacity, modern avionics meeting navigation requirements beyond 2020, modernized components to address obsolescence, and improved corrosion protection. Customers will be offered the option of fitting the CL-415’s four-door drop system for increased flexibility over the CL-215’s two doors.

Firefighters are also beginning to embrace unmanned aircraft systems (UAS) meanwhile. Small UAS have been more of a hindrance to operations so far, with drone sightings forcing aerial operations to be halted. But in 2017 the Los Angeles Fire Department used drones for the first time to survey burn areas and assess hot spots.

Larger UAS capable of being used to fight fires are on the horizon but will pose certification challenges. Spanish company Singular Aircraft, for example, is flight-testing the Flyox, a twin-engine amphibian with a maximum takeoff weight of 8,800 lb. and a 4,000-lb. payload, for roles including waterbombing.

In the U.S., Thrush Aircraft is considering development of an optionally piloted version of its Model 510 agricultural aircraft for aerial surveillance and fighting fires. The Albany, Georgia-based manufacturer has teamed with Drone America of Reno, Nevada, to potentially develop “the world’s first autonomous air tanker.”

Thrush says it is still “very early days” and no decisions have been made about the final design. But the partnership, announced in January, will initially focus on unmanning the civil-certified 510. Thrush has already adapted the manned aircraft for aerial firefighting as the 510G Switchback, which was recently purchased by Georgia’s Forestry Commission.

Powered by a single 800-shp General Electric H80, the aircraft can carry approximately 510 gal. of liquid for spraying and can quickly switch between firefighting and crop dusting, says Thrush. By incorporating Drone America’s UAS technology and increasing capacity to 800 gal. of water or retardant, the company hopes to produce an optionally piloted aircraft that can operate day or night.

The main reason for flying autonomously is to remove the pilot for riskier operations. In the U.S., aerial firefighting typically ends at sundown due to crew safety concerns, but that is usually the optimal time to tackle fires. “Currently, only manned air tankers are used in airborne firefighting operations, and they are restricted from fighting fires during nighttime hours,” the companies say. “However, it is during this ‘dark window’ that autonomous tankers can take special advantage of the cooler temperatures and reduced fire activity to support tactical ground operations, without risking the lives of pilots.”

Drone America is already developing the Ariel UAS, a prototype tandem-propeller amphibian that has been promoted for firefighting and surveillance roles. The company has also proposed an Ariel Scooper Drone for waterbombing operations, but an unmanned version of the 510 might be certified more quickly. “We founded our company on the belief that highly reliable, well-integrated autonomous systems can significantly improve public and environmental safety,” says Drone America President and CEO Mike Richards. “Our collaboration with Thrush represents a major step forward in achieving that goal.”

“We are applying our design, manufacturing and flight-test capabilities to a whole new generation of autonomous aircraft that can do things manned aircraft simply can’t do safely or as efficiently,” adds Thrush President Payne Hughes.
Anatomy of an
S-70i Firehawk

Sikorsky’s latest Firehawk multirole firefighting helicopter is based on the S-70i international version of the UH-60 Black Hawk, produced in Poland by subsidiary PZL Mielec. United Rotorcraft will be the prime contractor for Cal Fire’s S-70i Firehawks.

1. External Rescue Hoist
   - Accommodates 12 fire crew

2. Crew Seating
   - Accommodates 12 fire crew

3. Night Vision-Compatible Interior Lighting

4. Glass Cockpit With Digital Automatic Flight Control System

5. Tactical Communications System

6. Satellite Communication/Tracking System

7. High-Intensity Searchlight

8. Removable 1,000-gal. Water Tank

9. Extended Main Landing Gear
   - Provides sufficient clearance for water tank

10. Retractable Snorkel
    - Pumps 1,000 gal. of water in 45 sec.

11. Patient Litters (2) and Medical Equipment

Note: Pictured is one of three earlier S-70A Firehawks operated by the Los Angeles County Fire Department.
Even as energy prices begin to edge up, albeit slowly, the increases seem unlikely to absorb the overcapacity in the market that has seen dozens of aircraft languish in storage.

Few if any orders have been placed for heavy aircraft for the oil and gas sector over the last two years. Instead the biggest market for these aircraft has been a resurgent defense sector; Airbus’ Super Puma family enjoyed a bumper year, thanks to several key government orders. Just a handful have made their way into the commercial market, largely to serve the para/public-service sector missions such as law enforcement and search and rescue.

The market has prompted Airbus to rethink the launch of its Super Puma replacement, the X6.

Sikorsky also, with only two commercial products in its lineup, is struggling to shift both the medium-twin S-76 and S-92 heavy models. Industry sources suggest just one S-92 was delivered during 2017, and Lockheed Martin Chief Financial Officer Bruce Tanner admits that the situation was bleak, stating the company is not expecting a large increase in commercial aircraft for 2018. “Frankly,” he told financial analysts, “we are looking pretty flat in 2019 as well.”

Instead, the energy industry now seems to favor newer super-medium aircraft such as the Airbus H175 and Leonardo AW189. Bell’s 525 will join this segment in 2019.

Waypoint Leasing, which analyzed the super-medium market late in 2017, concluded that this new segment of aircraft has delivered platforms that are more cost-effective than the heavier types such as the H225 and Sikorsky S-92, particularly on shorter-range, high-passenger-density flights.

Waypoint says it expects the super-mediums to sell well in the rebounding oil market.

This appears to match forecasts from consultancy Westwood Global Energy, which predicts an uptick in activity for the oil-and-gas helicopter operators. It says the new oil finds and the exploita-
Helicopter OEMs are increasingly seeing wind-farm support as a growing market for light and medium helicopters.

### Helicopters on the Horizon

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*Sources: Manufacturers*
tion of untapped reserves in the Mediterranean and East Africa will require new bases and the return to service of some surplus and stored aircraft.

The company says the industry is emerging from record lows, with fleet use falling to 54% during 2017 because of reduced demand for offshore flights.

For Leonardo, 2017 was a difficult year. Its helicopter division was spooked by production problems for the AW169 and AW189 models, which pushed up cost and led to significant delivery delays. One of the problems was the company’s push to chase orders and be overly flexible with aircraft configurations, even as they were on the production line. Helicopter division Managing Director Gian Piero Cutillo says the company lost discipline but is now in the process of restoring order.

However, the issues illustrate the highly competitive nature of the market and the small number of orders the manufacturers are having to chase.

The news is more positive for the lighter end of the market, with sales of light-single and twin-engine helicopters appearing stable. Airbus, whose deliveries and orders were announced in January, secured most of its orders from its single-engine family, though 76 of the 388 aircraft ordered in 2017 were its H145 twin-engine model. Leonardo, which faced struggles with its helicopter division during 2017, said it was confident of a growing market.

Its analysis suggests the commercial market will grow around 5% over the next five years, about 9% of which will occur in what he calls the “intermediate segment”—aircraft weighing 3-8 metric tons.

Stiff competition is ongoing at the lighter end of the market, particularly from Bell’s 505. The Robinson R66 did manage to kill off the Airbus H120 Colibri and Bell’s own 206L LongRanger during 2017, indicating the sensitivity of pricing in this busy sector.

It is possible that some critical markets may hold the key to future success. The long-heralded Chinese scene may not have fully opened as expected by now, but the vast market potential here is beginning to be realized. In 2016, China was Airbus’ biggest market and since then Chinese companies have placed several large orders with Western OEMs. Airbus also will start to build its H135 twin-engine medium helicopter in Qingdao this year following an order for 100 aircraft, of which 95 will be assembled from kits transferred from Airbus’ plant in Donauworth, Germany.

Last June, Bell took orders for 100 of its 407GXPs from Shaanxi Aviation Industry Development Co. and Xian Helicopter, while 110 of its 505 JetRanger Xs have been ordered by Reignwood Investments (these encompass several disparate buyers). Leonardo also recorded a sizable order for 30 of its AW139 and AW169 medium helicopters in late 2016 to serve emergency medical missions.

“We continue to feel very good about China in terms of how we’re doing and particularly on the light [helicopter] side,” said Textron President Scott Donnelly during the company’s fourth-quarter financials presentation at the end of January.

Of course, 2018 should also be a milestone for first flights and certification. Bell’s long-awaited fly-by-wire 525, which resumed flight-testing last July after its fatal crash a year earlier, is targeting FAA certification by the end of this year, possibly paving the way for customer deliveries in early 2019.

Meanwhile, market newcomer Turkish Aerospace Industries plans the first flight of its twin-engine T-625 medium twin-engine helicopter for September.

Although initially being developed to meet Turkish military/parapublic requirements, the company wants to achieve European Aviation Safety Agency certification of the aircraft in 2020 and compete in the space currently occupied by the Bell 412, Leonardo AW139 and Sikorsky S-76D.

Avicopter’s AC352, the Chinese-built derivative of the Airbus H175, is also expected to achieve certification this year. The aircraft is awaiting local certification of its WZ-16 engine, which is expected in 2019.

However, several programs encountered additional delays, pushing service entry into 2019. Market newcomer Kopter Group, previously Marenco Swisshelicopter (see page 52), hopes to introduce its SH09 single-engine light helicopter to the market after certification, now planned for the first quarter of 2019. Airbus, in the meantime is continuing the development of its H160, targeting an mid-2019 certification and market entry.
Airbus is exploring the potential of widening the scope and capability of its future Health and Usage Monitoring Systems (HUMS) to provide earlier detection of potential problems with the moving components inside helicopter transmissions.

The research—an in-house project—is an offshoot of the company’s engineering work following the fatal crash of one of its H225 helicopters in Norway in April 2016.

In simple terms, helicopters’ HUMS use a series of accelerometers placed at critical points in the aircraft’s dynamic system such as the main and tail rotor gearboxes to monitor vibration levels. Variations detected can provide imperative early warning of a potential issue.

In the Norway accident, Airbus and Norwegian investigators believe the accident likely was caused by spalling within the outer ring of one of eight planet gears within the main gearbox. This resulted in a crack that propagated, causing it to split in two between two teeth and collide with a tooth on the sun gear.

Within moments, the inertia of the helicopter’s main rotor sheared off the top section of the main gearbox, which resulted in the main rotor head and blades separating from the aircraft.

But trying to detect a potential problem in this section of the gearbox—where the planet gears are operating and dozens of parts are intermeshing simultaneously and at different speeds depending on the mission and environment in which they are operating—is a significant challenge.

“It is like attempting to find an irregularity in the heart of child while they sit in a classroom with other children, using sensors placed out on the outside of the building,” says Regis Magnac, Airbus head of customer relations.

“There are hundreds of points of connection that are turning very fast at different rhythms. . . . It is very noisy and there are so many frequencies,” he says.

But data collected during test bench trials and flight tests suggest new-generation sensors combined with advanced algorithms and data processing could provide extremely early warning of component degradation.

As part of the engineering work, Airbus has been assessing H225 gearboxes on a static test bench. The gearboxes hold additional sensing equipment. Artificial degradation was added to components to see how it would evolve.

The new sensors, capable of seeing higher bandwidths of frequencies than previous generations, have been providing a lot of new data, says Magnac. This data was then worked through different algorithms, and an “evolution of the propagation,” has been tracked through those algorithms.

“I am not saying we have found the gold solution, but we’ve seen some interesting developments; interesting enough for us to continue to deep dive into it,” says Magnac. “It’s not for the near future, that’s for sure.”

The trials may be at an early stage, but Airbus is working with several customers on the installation of monitoring equipment, separate from the HUMS. Ten H225s will be outfitted to supply operational data in the coming months.

“If you want to understand and detect an irregularity in a heartbeat, you obviously need to know what a healthy heart is doing,” says Magnac. “We need to go through that in order to make sure our understanding of what is good is right in order to better tune our algorithms to what we want to look at,” he adds.

By using customer aircraft, Magnac says Airbus will be able to build data from aircraft operating in different environments as well as gather it far more quickly than it would simply by using its own test aircraft. The company is preparing a data center to collect the information from the aircraft to feed the research program.

A key part of the work has been studying the best positioning of the additional sensors around the transmission.

“Where a doctor places his stethoscope, you will hear different things . . . so the algorithms need to be tuned for a certain position,” says Magnac.

Rotary-wing aviation may be evolving toward multirotor systems, but while the traditional helicopter remains in operation, the main gearbox will always be what Magnac describes as a potential “single point of failure,” which cannot be resolved through redundancy like other aircraft systems. Additional monitoring can provide additional reassurance, he says.

The H225 is the focus of the company’s research now, but success could lead to the technology eventually having implications beyond helicopters.

“Cyclic gear trains are used in many industries, not just helicopters, but also in cars and wind turbines,” Magnac says, adding, “There is criticality in anticipating what happens in those [wind turbines], but such a system does not exist.”

Airbus Big Data Project Could Bring Earlier Warnings of Gearbox Faults

Tony Osborne, London

NEW SENSORS SPOT DEGRADATION IN MOVING ELEMENTS

SENSOR KITS ON 10 H225s TO TRACK ‘HEALTHY’ OPERATING REGIME
Kopter Branding Breathes Alpine Air into Swiss Helicopter Program

Tony Osborne | London

Kopter is the new name for Switzerland’s fledgling helicopter OEM Marenco Swisshelicopter. But can a new Germanic-style identity and a fresh-faced management team get the long-running development of the company’s SH09 single-engine light helicopter back on track?

Andreas Loewenstein, who took over as Kopter Group CEO in January 2017, says customers are “impatient” to get the aircraft, and “interest is increasing,” despite certification time-tables being pushed to the right again and again since the SH09’s first flight last Oct. 14.

“The helicopters in the single-engine segment are rapidly aging; they were certified 30–40 years ago,” he says. Operators are looking for new technology and Kopter’s competitors such as Airbus with its H125, Bell with its 407, and the Leonardo AW119 Koala have not been keeping up.

This is largely true, the two competitor aircraft have been given cursory cosmetic enhancements, with upgraded avionics keeping them relevant. Bell’s introduction of a glass cockpit with the 407GX and GXP has given new life to that program and Airbus is promising digital upgrades of its single-engine family to be announced at HAI Heli-Expo in late February.

The Honeywell HT900-powered SH09 is a 2.65-metric-ton conventional helicopter with a five-blade main rotor and a shrouded tail rotor. Capable of seating seven passengers, the SH09 also has been designed with clamshell doors in the rear fuselage, a feature usually found only on larger twin-engine models. Other design characteristics include a carbon-fiber airframe.

Conceivably, the SH09 also could siphon market share from popular light-twins such as the Airbus H135, Bell 429 and Leonardo AW109.

But Kopter Group’s progress has been slow; the first prototype, P1, flew a total of just 1.5 hr., and the second, P2, has flown 70. Attention is now on a third prototype, P3—due to fly in March—and on an aircraft codenamed PS4, a preproduction-standard aircraft set to fly this fall. The latter two will be used for the extensive flight-test program that will be needed if the company wants to achieve its timetable of European Aviation Safety Agency (EASA) CS27 certification in early 2019, with FAA certification expected several months later.

First customer deliveries are planned for the second quarter of 2019.

To increase the tempo of flight testing, the team will move away from the mountainous valleys of Switzerland and head for Sicily seeking weather more conducive for the test regime.

At Kopter’s headquarters in Wetzikon near Zurich, Loewenstein says the company is transforming “from an engineering organization into a helicopter manufacturer.” He adds, “We have had a great development program, but now we need to bring the aircraft to the market.”

Part of this has been about building the company’s product support and supply chain from naught. While assembly facilities are being opened at the nearby Molli airfield, a pre-assembly supply-chain facility and a final assembly line building have all been established. Its workforce of 253 is set to grow by around 100 during 2018.

Loewenstein is looking beyond the immediate future. Noting that nearly half of its current orders are from U.S.-based clients, he sees the possibility of an assembly line there. And given that China’s burgeoning market cannot be underestimated, he suggests that a final assembly site in Asia could be in the cards at some point.

Kopter already has sold out its first two years of production. Loewenstein says the company holds 27 firm orders with down payments, while 19 more are contingent on certification. The company also has 120 letters of intent, of which the majority, he says, will be turned into contracts.

Concurrent with pursuing certification, Kopter has its engineering team working on an array of potential mission equipment. Loewenstein, saying he wants the aircraft to be the “Swiss army knife” of the air, is keen to avoid the mistakes of other OEMs, namely keeping some customers waiting for mission equipment to be certified.

Among the kits already in progress is an emergency medical service (EMS) interior designed by Air Methods, while a cargo hook for external load lifting has been developed for utility work. Other customers for the SH09 include air taxi and aerial tourism companies. EMS operations with the aircraft are likely to be restricted to the U.S. for now as EASA rules prohibit EMS operations with single-engine aircraft.

Kopter still has a lot to prove, particularly to its investors, but Loewenstein says the change in name helps let people know “we have arrived—and we are here to stay.”
T

20 months after a fatal crash resulted in the loss of the first prototype, Bell Helicopter is blazing a trail to achieve certification of its fly-by-wire Model 525 super-medium twin-engine helicopter by year-end.

The flight-test fleet was immediately grounded after the crash of the orange-painted Flight Test Vehicle 1 (FTV1) on July 16, 2016, and the fleet did not fly again until 366 days later. Today, Bell says it is heeding the lessons learned from the accident and using the fly-by-wire technologies to mitigate its causes.

The National Transportation Safety Board findings, published in January, found that severe vibration had caused unintentional control inputs, so-called biomechanical feedback, from the pilots that led in turn to the main rotor speed slowing down and to the blade flapping out of plane, causing it to slice off the tail boom, culminating in the inflight breakup of the aircraft.

Bell has designed a series of control law filters for potential issues of biomechanical feedback in the cyclic control laws but had not developed them for the collective. It is now in the process of doing so, both in simulators and flight-test, to prove that the fly-by-wire flight control system can resolve the issues.

Additional control system filtering also was applied to the system that is used to stabilize the helicopter in gusts and maneuvers.

“A big part of the flight testing has been proving that we can address the rotor dynamics using the fly-by-wire control system,” says Chief Engineer Chris Cawelti. He notes that he could not provide a time line for when the work would be complete, but that “substantial progress” had been made.

“With a traditional mechanical flight control system, the solution would be overly complex,” Cawelti says.

The accident has resulted in a lengthy delay in bringing the aircraft to market, although engineering work on the program continued using ground test rigs and simulators.

“The program was fully staffed [during the grounding] and continued to make progress,” Cawelti says.

Bell is targeting the end of 2018 to achieve FAA Part 29 certification for the aircraft, says Byron Ward, vice president for the 525 programs, but he notes they may have to request an extension from the FAA, which could nudge the time line into early 2019.

The company’s two remaining prototypes, FTV2 and FTV3, have been worked hard since they were cleared to return to flight operations last July, flying 200 flight hours in half a year. The second aircraft, FTV2, was at the time of writing performing cold weather trials in Thompson, Manitoba, where the aircraft has been cold-soaked to temperatures of around -40°C (-40°F). Both flight-test aircraft have proved to be extremely reliable, says Ward, noting the only issues to impinge on test operations were associated with the test instrumentation. FTV3 has been involved in flight envelope expansion.

The two FTVs will be joined later this year by AC14, a pre-serial production aircraft expected to fly mid-year.

Bell’s 525 will be the largest of the new-generation super-medium helicopters on the market when it arrives in 2019.

It will be used to perform electromagnetic, environmental-effects testing and for the certification of optional equipment. Bell aims to have 30 supplementary type-certified optional extras available when the aircraft comes to market. AC14 also will be involved in the development of the 525’s full icing protection system (FIPS), approvals for which will follow after type certification.

At the end of the year, another development aircraft, AC15, will support development of the equipment packages. Bell is planning to have two configurations of the aircraft ready at certification, including a transport layout suitable for offshore oil and gas support and a VIP package.

Search-and-rescue and public-service capabilities will be set when the FIPS system has been certified.

Despite the delays stemming from the accident, Ward says, more customers are showing interest in the aircraft, notably the capabilities provided by the fly-by-wire control system, particularly in terms of operating in degraded visual environments. The aircraft will also be one of a handful on the market capable of operating so-called Category A take-offs and landings at maximum gross weight, thanks to the power provided by GE CT7-2F1 turbines. Maximum takeoff weight is currently 9.3 metric tons (20,500 lb.).

Cat. A defines a multi-engine helicopter capable of safely flying away in the event of engine loss.

When it enters service, the 525 will join what appears to be an increasingly competitive market for super-medium-segment helicopter. The 525 will be the largest and most powerful in terms of engine performance of the super-mediums, which also include the Airbus H175 and Leonardo AW189; it will be the only one capable of carrying up to 19 passengers, compared to 16 for the other two, although Leonardo is looking at a 19-passenger fit for the AW189.

Bell Pressing Ahead With Fly-by-Wire 525 Certification

> PRE-SERIAL PRODUCTION AIRCRAFT TO JOIN FLIGHT-TEST PROGRAM

> FIRST PROTOTYPE CRASH PARTLY RELATED TO SEVERE VIBRATIONS

Tony Osborne London
Each year, Aviation Week, in collaboration with the American Institute of Aeronautics and Astronautics (AIAA), identifies and honors 20 university students who are on track to create the future of the industry.

With nominations from engineering programs at 35 universities on three continents, a panel of judges from AIAA comprised of hiring managers and academics looked for what sets the mark in a student they would want to hire—a fire for digging deeper and working harder to discover something new and an interest in and concern about the world beyond their studies.

While these students will stand side by side with the elite of the industry March 1 at the annual Aviation Week Laureate Awards gala, they have a few tips about the future for those who built the industry of today.

In a nod to Frank White's 1987 work *The Overview Effect*, the students overwhelmingly look to space when they envision the future. White posited that when astronauts are in space, "looking at Earth amidst the dark, silent vastness of the universe," they look at the planet in a different way. The students say space tourism will bring us closer to cherishing the planet and all who live on it. They believe we will become a multi-planet species and that the aerospace and defense industry will play a starring role in building the framework to support this.

The excitement of the new space race plays a part in these thoughts, and so does the consistent presence of NASA through funding, internships, mentors and large-scale missions in the research they undertake.

In turn, these “20 Twenties” have a strong perspective about the engineering challenges required to build such a future:

• **Environmental protection:** Ensure food and water security; mitigate overpopulation; use safe, efficient and environmentally conscious transportation (from ground vehicles to air taxis to space debris brought on by an increased presence in space); employ clean and sustainable energy.

• **Artificial intelligence:** Wisely foster and control the emergence of new technology.

• **Misinformation:** Guard against the negative effects of disinformation in emerging media outlets and social media.

The 20 Twenties also cited what has been most helpful to them in working toward their academic degrees and launching careers:

• **Mentors and a network** that helped mold their perspectives and encouraged their dreams.

• **Internships.**

• **Experiencing different cultures** and ways of looking at the same problem, whether as an international student or via volunteer experiences.

**AIAA 20 Twenties Judges**

**Thomas Becher**
Technical Director, Mitre Corp.

**Steven Collicott**
Professor, Purdue University

**Kevin Duda**
Principal Engineer and Group Leader, Charles Stark Draper Laboratory

**Lee Ho-Jun**
Research and Development Engineer, NASA Johnson Space Center

**Dan Jensen**
Engineering Head for Services, Propulsion and Power Systems, Rolls-Royce Corp.

**Kurt Polzin**
Research and Development Engineer, NASA Marshall Space Flight Center

**Ubair Rehmanjan**
Systems Engineer, Qantas Airways
The 20 Twenties also cited what has been most helpful to them in working toward their academic degrees and launching careers: internships, mentors and a network by an increased presence in space; employment clean and sustainable transportation (from ground vehicles to air taxis to space debris brought ships, mentors and large-scale missions in the research they undertake. The students say space tourism will bring us closer to the future of the industry.

While these students will stand side by side with the elite of the industry March 1 at the annual Aviation Week Laureate Awards gala, they have a few tips about the future for those who built the industry of today.

The Overview Effect

Aguilar has interned at the university’s Lincoln Laboratory Advanced Sensors and Techniques unit, NASA’s Jet Propulsion Lab and Micron Technologies. Her research has focused on Cubesat Laser-communication Infrared Crosslink (CLICK) to demonstrate a laser cross-link between two spacecraft at 20 Mbps. She has been responsible specifically for trade studies on receivers using a time-to-digital converter and the design of an optical receiver.

Matthew Asper

B.S. Aerospace Engineering; Minor in Materials Science and Engineering Class of 2019 University of Virginia

Matthew Asper, a junior, is president of the AIAA branch at UVA, founder of the university’s first combat robotics team, treasurer of the cycling club and treasurer of Tau Kappa Epsilon fraternity. He also organized UVA’s 2017 Rotunda Dinner.

Asper interned as a project engineer at Xometry, a 3D-printing and manufacturing company in Maryland. He is researching two different methods of aircraft deicing: one using a hydrophobic coating to mitigate ice accretion and the second using a ceramic, porous material that employs backpressure to reduce ice accumulation.

Aaron Aboaf

B.S. Aerospace Engineering Sciences Class of 2019 University of Colorado-Boulder

Aaron Aboaf has completed internships with Raytheon Missile Systems and is the structural design lead on two cubesats—the Colorado Earth Escape Explorer (CU-E3) and Maxwell. CU-E3 took second place in NASA’s Cube Quest challenge, qualifying it for a launch spot on the first flight of the Space Launch System.

Aboaf is also a student ambassador for the university, leading campus tours for prospective students, and he volunteers with Colorado’s AeroSpace Ventures Day. He honed his leadership skills as a sailing instructor at Greenwood Village, southeast of Denver.

Alexa Aguilar

M.S. Aerospace Engineering • Class of 2019 Massachusetts Institute of Technology

B.S. Electrical Engineering • Class of 2017 • University of Idaho

As an undergraduate in electrical engineering at the University of Idaho, Alexa Aguilar helped to attract young people to engineering careers as a university representative, and as member of the university’s Electrical and Computer Engineering Ambassadors, she worked to increase enrollment by 4.3%. She was also active as a volunteer at the local Humane Society and participated in Idaho’s Center for Volunteerism, working with children and nursing home residents.

While at MIT, Aguilar has interned at the university’s Lincoln Laboratory Advanced Sensors and Techniques unit, NASA’s Jet Propulsion Lab and Micron Technologies. Her research has focused on Cubesat Laser-communication Infrared Crosslink (CLICK) to demonstrate a laser cross-link between two spacecraft at 20 Mbps. She has been responsible specifically for trade studies on receivers using a time-to-digital converter and the design of an optical receiver.

Estefania Bohorquez

B.S. Civil Engineering Class of December 2017 University of Central Florida

In addition to participating in outreach activities to high school students on behalf of the student chapter of the Society of Hispanic Professional Engineers, Estefania Bohorquez volunteered with the Central Florida chapter of the Juvenile Diabetes Research Foundation. She also participated in Engineers Without Borders.

Bohorquez’s research has been focused on propulsion and engine materials, specifically thermal barrier coatings. She worked in collaboration with DLR, the German research center for aeronautics and space, to test samples of sand-infiltrated coatings through 3D confocal Raman imaging to develop coating life prediction.

She interned with Siemens Power & Gas and the Walt Disney Co. Bohorquez also served as a research project lead for the NASA Florida Space Grant Consortium.
Nicholas A. Branch
B.S. Aerospace Engineering • Class of December 2017
Georgia Institute of Technology

While he was a student at Georgia Tech, Nicholas Branch gained experience working with the university’s High Power Propulsion Technology lab as well as with SpaceX’s Dragon 2 ground operations and at NASA Marshall Space Flight Center. His research has focused on demonstrating the validity of terahertz laser diagnostics in electric propulsion and on providing valuable characterization of transient states of plasma.

Branch’s community service included Georgia Tech Trailblazers for outdoor environmental service and Team Buzz for Atlanta-based community service. He also was a Georgia Tech campus first responder. Branch worked with the university’s outreach programs, including one-on-one mentoring, to inspire K-12 interest in science, technology, engineering and math.

Arthur J. Brown
M.S. Aeronautics and Astronautics
Class of 2018
Massachusetts Institute of Technology
B.S. of Applied Science Engineering (Aerospace Engineering Major)
Class of 2016 • University of Toronto

Beyond the classroom, Arthur Brown is active with the Academy of Courageous Minority Engineers and the MIT Graduate Student Council’s Diversity and Inclusion Subcommittee. At the University of Toronto, he was a member of the Engineering Science basketball team.

Brown was a researcher for the computational aerodynamics lab at Toronto and completed pilot flight training in five weeks. He is now conducting a trade study between several proposed on-demand vehicle configurations. As part of this work, he developed a vehicle design and optimization tool.

Luke Bury
Graduate Student, Aerospace Engineering-Astrodynamics
University of Colorado, Boulder
B.S. Aerospace Engineering-Space Flight
Class of 2015 • University of Texas-Austin

At the University of Texas-Austin, Luke Bury was one of six undergraduates chosen for the Engineering Student Leadership Award, and he was a member of Sigma Gamma Tau, the National Aerospace Engineering Honor Society.

He served as president of the AIAA student branch at Texas, and at Colorado he continues to volunteer with science, technology, engineering and math outreach efforts including at the Girls Athletic Leadership Schools Denver.

Bury is working to create a new framework for landing spacecraft on moons of the outer Solar System via low-energy dynamics, a four-stage project designed to inform energy trajectories, maneuvers and landing and recovery/abort procedures. He interned with NASA Jet Propulsion Laboratory’s Europa Clipper Mission and was a researcher with the Texas Spacecraft Laboratory.

Rosemary K. Davidson
B.S. Aerospace Engineering • Class of 2018
University of Maryland

A founding member and then president of Women in Aeronautics and Astronautics, Rosemary Davidson was a resident assistant for 80 residents in the Women in Engineering Living and Learning Program. She is a member of AIAA and vice president of Sigma Gamma Tau, the National Aerospace Engineering Honor Society.

Davidson’s research has focused on design of an attitude control system for a cubesat proposal at NASA Goddard Space Flight Center. The mission is to compare in situ electron measuring with imaging inside the aurora borealis. She currently is working on verification simulation of the controller.
Jessica Lillian Dedeaux
B.S. Aerospace Engineering • Class of 2018 • Tuskegee University

After she graduates in May, Jessica Lillian Dedeaux will begin work at Boeing in July as an engineer in the Engineering Career Foundational Program. In addition to interning with Boeing, Dedeaux interned at the GE Aviation Composites operation in Batesville, Mississippi, where she compiled a science, technology, engineering, arts and math lesson plan at the Boys and Girls Club for students in grades three to six.

As the chief engineer on Tuskegee’s rocketry design, Dedeaux researched the pressure, temperature, relative humidity, solar irradiance and ultraviolet radiation in relation to the strain placed on the material selected for the rocket’s fins from the time of apogee until recovery.

She also was selected to represent Tuskegee on a multi-university team to design, build and fly a UAV, leading the 3D experience software effort.

Dedeaux is a member of the National Society of Black Engineers, executive secretary of the Student Government Association at Tuskegee and a member of the Marching Crimson Pipers Band. She completed the university community service initiative with 400 service hours and was named the 88th Miss Tuskegee University.

Katherine Fowee
M.S. Aeronautical and Astronautical Engineering • Class of 2018
B.S. Aeronautical and Astronautical Engineering • Class of 2016
Purdue University

Katherine Fowee is a member of the Purdue Flying Club; Sigma Gamma Tau, the National Aerospace Engineering Honor Society; Pi Delta Phi, the National French honor society; and the Daughters of the American Revolution. She has participated in science, technology, engineering and math outreach programs and as a volunteer for a local Boy Scout troop.

As a Division I soccer player at Purdue, part of the Big Ten Conference, Fowee was an Academic All-Big Ten honoree in 2013 and 2014.

She is conducting research on an experimental micropropulsion device for small-satellite attitude control called the Film Evaporation MEMS Tunable Array (FEMTA). (MEMS stands for microelectromechanical systems.) FEMTA uses the microcapillary action of water in a microchannel to generate micronewtons of thrust when exposed to a vacuum. For this research, Fowee has been involved in nozzle design, micro-fabrication techniques and testing.

James H. Gong
B.A. Computer Science • Class of 2019
Columbia University

Concentrating on astrophysics and business, James Gong was chosen for the King’s Crown Leadership Excellence Award in Innovation at Columbia, where he is co-president of the Columbia Space Initiative. He is vice president of Columbia Undergraduate Film Productions, combining his engineering interests with filmmaking. This led to an internship at Lucasfilm, where he worked on developing CGI and simulations tools, including space combat applications. He also interned at Nielsen.

Gong’s research work has been associated with NASA’s Revolutionary Aerospace Systems Concepts-Academic Linkage design competition to deliver a crew of four humans to the Martian moon. Gong is the lead on the Columbia team, responsible for identifying subsystem requirements for the mission architecture, making design decisions at the system level and subsystem integration.

Christine Greve
Graduate Student, Aerospace Engineering
Class of 2021 • Texas A&M University
B.S. Aerospace Engineering • Class of 2017
University of Oklahoma

While at Oklahoma, Christine Greve was a member of the Crimson Skies Design/Build/Fly team as well as the Student Advisory Council, AIAA student branch, ballroom dance club and the university’s musical competition team. She also took part in the Norman, Oklahoma, Rotary Club and coordinated philanthropic events for Oklahoma Coalition Against Domestic Violence and Sexual Assault.

Greve is a graduate assistant researcher in the plasma dynamics modeling lab at Texas A&M and has interned at the NASA Marshall Space Flight Center. Her current research work involves the development of a fully self-consistent, particle-in-cell kinetic model to investigate Hall thruster discharge plasmas.
Namrah Habib
B.S. Aerospace Engineering/B.S. Chemical Engineering
Class of 2018 • University of Arizona

In addition to her studies, Namrah Habib competes at the national level in kickboxing and Brazilian jiu-jitsu. She is a member of the Tau Beta Pi engineering honors society and the university’s Women in Engineering Programming Board, creating campus events and science, technology, engineering and math outreach initiatives.

Habib works with the image-processing working group on NASA’s Origins Spectral Interpretation Resource Identification Security-Regolith Explorer (Osiris-Rex) program. She is using feature-based matching tools and integrated software imagers to produce an algorithm to generate a controlled mosaic of the asteroid Bennu. She has completed internships at the university’s Lunar Planetary Laboratory as well as NASA Glenn Research Center and MIT Lincoln Laboratory.

Jared Ham
B.S. Mechanical Engineering/B.S. Computer Science
Class of 2020 • Colorado State University

Jared Ham is president of the AIAA student branch at CSU, which has recently tripled in size. He is project manager and head engineer of the university’s Design/Build/Fly Competition. A member of Pi Tau Sigma, the International Honor Society for Mechanical Engineers, he also interned as a mechanical engineer with NASA’s DemoSat program in Fort Collins, Colorado.

Ham currently is working on design and modification of a remote-control airplane to measure concentrations of methane and ammonia over dairies and feedlots using laser-based sensors.

Seamus Lombardo
B.S. Aerospace Engineering
Class of 2018
University at Buffalo, State University of New York

Seamus Lombardo has a patent pending for a device to extract multiple samples while avoiding cross-contamination. He has been an intern at NASA Langley Research Center and Goddard Spaceflight Center. Lombardo also worked as a data and control systems intern at SpaceX’s McGregor, Texas, site and was an avionics intern at Millennium Space Systems in El Segundo, California.

Lombardo co-led the attitude determination and control subsystem effort on Buffalo’s nanosatellite program sponsored by the Air Force Research Laboratory and NASA. In addition to design, testing and characterization of flight hardware, he worked on developing orbit propagator and attitude exclusion zone algorithms.

Matthew L. Marcus
Graduate Student, Aerospace Engineering
University of Maryland
B.S. Aerospace Engineering
Class of 2013
University of Maryland

In addition to his research work on satellites and planetary defense, Matthew Marcus works with NASA Goddard Space Flight Center’s Satellite Servicing Projects Division. He received an Innovation Award from the Society of Satellite Professionals International for a talk titled “LEO Debris Removal using Genetic Algorithms,” and he is a National Science Foundation Graduate Research Fellow. In addition, Marcus is active in AIAA’s student programming board and Women in Aeronautics and Astronautics at UMD.

Marcus participated in the design of the University of Maryland’s prizewinning entry in the U.S. Department of Energy’s Solar Decathlon and performed energy audits of local schools to identify areas of improved energy use.
Kimberly A. Q. Rink
M.S. Aeronautics and Astronautics • Class of 2019 • Purdue University
B.S. Aeronautical and Astronautical Engineering • Class of 2017 • Purdue University

Kimberly Rink interned at NASA’s Jet Propulsion Laboratory and Johnson Space Center as well as with Boeing Commercial Aircraft’s advanced concepts group. Her research work is investigating the impact of deviations from the design process on robotic science missions. She is identifying historical design deviation cases and their impact on mission objectives, leading to a database that will be used to create a prototyping tool.

Rink is a member of the Purdue Student Engineering Foundation and took part in The Atlantic’s What’s Next? Innovation summit. She has volunteered with Habitat for Humanity in Rochester, Minnesota, and was a volunteer and young volunteer board member at the Mayo Clinic.

Jocelino Rodrigues
Graduate Program in Aerospace Engineering and Physics
University of Cambridge • Undergraduate degree in Aerospace Engineering
Class of 2016 • University of Bristol

In addition to his undergraduate degree, Jocelino Rodrigues completed a year abroad at Purdue University working on rocket and jet propulsion. He won third place in the Airbus National Student Space Competition and has been recognized by both Rolls-Royce and Qualcomm. He was the youngest candidate chosen for the Lynx Space Academy conducted by XCOR Aerospace.

His current research is investigating how varying geometry and flow conditions affect aircraft noise (direct and indirect) generation. This will include use of advanced optical diagnostics techniques to measure flow velocity and local sound speed, as well as extending the study of indirect noise to higher frequencies and the role of turbulent dispersion in attenuating inhomogeneity waves. When he isn’t studying thermoacoustics, Rodrigues is the studio equipment officer for the Churchill College Music Society and is working with the university to analyze and improve diversity among engineering students.

Kenneth Wayne Smith, Jr.
Graduate Student, Aerospace Engineering
Georgia Institute of Technology
B.S. Aerospace Systems Engineering
Class of 2015 • University of Akron

Ken Smith interned at NASA Langley, Glenn and Kennedy Space Centers in addition to a stint as a dynamics intern at SpaceX. While at Langley, he volunteered with the Virginia Air and Space Center and Virginia Salvation Army. He was awarded the University of Akron’s Community Leadership, Service and Philanthropy Award.

Smith’s research involves the impact of wind-induced oscillations (WIO) on circular cylindrical structures, such as a launch vehicle on the pad. He has worked specifically on developing a model of existing launch vehicles for use in wind tunnels and to assess the aerodynamic conditions at which a vehicle becomes susceptible to WIO.

Jeremy C. H. Wang
B.A. Science in Aerospace Engineering
Class of 2017
University of Toronto

Jeremy Wang has a vision of enabling socially conscious innovation and already has secured $45 million and 90-plus sponsors and investors for tech startups, design teams and events.

Wang founded PowerWring in 2014, followed in 2016 by The Sky Guys, a startup to deploy disruptive UAV and artificial technologies to heavy industry across North America. He was chosen as a facilitator for the Institute for Leadership Education in Engineering at the university and also served as a mentor for the university’s Entrepreneurship Hatchery.

He was a propulsion research and engineering intern with the Institute of Space Propulsion German aerospace center DLR. He is the project lead for the DX-3, a vertical-take-off-and-landing (VTOL) unmanned vehicle. The DX-3 is intended to combine the endurance and range of traditional fixed-wing aircraft with the payload capacity and VTOL capability of a multirotor to be used in high-occupancy-vehicle lane enforcement on Ontario’s highways.
Aireon’s core business will be to provide aircraft surveillance data to subscribing ANSPs. Through a partnership with flight-tracking data company FlightAware, it is supporting a space-based automatic dependent surveillance-broadcast (ADS-B) network.

Aireon payloads on Iridium Next satellites receive ADS-B transmissions from aircraft, then route the position data through a ground network to air navigation service providers.

AIREON EXPECTS NEW SATELLITES WILL BE IN PLACE BY AUGUST
ELEVEN ANSPs HAVE SIGNED DATA-SERVICE AGREEMENTS
FAA CONSIDERS TRACKING OPTIONS FOR U.S. OCEANIC AIRSPACE

Bill Carey
McLean, Virginia

Even years after it started developing an aircraft surveillance system based on satellites, the Aireon joint venture of Iridium Communications, Nav Canada and other partners is close to providing air navigation service providers (ANSP) the “complete visibility” over oceanic and polar regions that it originally promised.

Aireon’s core business will be to provide aircraft surveillance data to subscribing ANSPs. Through a partnership with flight-tracking data company FlightAware, it is supporting a web-based tracking dashboard for airlines called GlobalBeacon. And its space-based automatic dependent surveillance-broadcast (ADS-B) network will be available to airlines, ANSPs and search-and-rescue organizations as a public service to locate missing aircraft in emergency situations.

In late December, launch company SpaceX delivered a fourth set of 10 Iridium Next satellites into orbit via a Falcon 9 rocket, marking the midway point of a launch campaign to position Iridium’s new generation of 66 operational and nine spare communications satellites.

Each Iridium Next satellite carries a 50-kg (110-lb.) Aireon receiver payload manufactured by Harris Corp. and tuned to capture 1090-MHz extended squitter transmissions—the frequency used for ADS-B. Fitted to the web of global-orbiting, cross-linked
satellites, the payloads receive ADS-B messages from transponder-equipped aircraft below, then stream the data to Aireon's ground network. From there, Aireon will process the data and distribute it to ANSPs that subscribe to its service.

SpaceX and Iridium planned four more launches through the first half of this year to complete the Iridium Next constellation—they scheduled the next, an Iridium-5 launch from Vandenberg AFB, California, on March 18.

Iridium conducts testing and validation of the satellites in a temporary parking orbit, then moves them to their operational orbit at 780 km (480 mi.) and positions them one by one near existing satellites. Intersatellite communication links from nearby satellites are pointed at the Iridium Next spacecraft, and existing satellites are eventually deboosted and deorbited. Plans call for having the full operational configuration of 66 satellites positioned in six polar orbiting planes—11 satellites per plane—by August.

As of January, Aireon had concluded data-service agreements, typically for 12-year terms, with 11 ANSPs. It had signed memorandums of agreement (MOA) with 19 ANSPs and four systems integrators involving 22 countries. The MOAs “we use to develop a value proposition, do a full exploration in consultation [with parties] of what their needs are and negotiate a long-term data service agreement,” explains CEO Don Thoma.

Aireon's strategic partners have invested $270 million in the company: Nav Canada has invested $150 million in five tranches; the Irish Aviation Authority (IAA), Italy’s Enav and Denmark’s Naviair, combined, have invested $120 million over four tranches. Iridium provided an initial seed investment of $12 million.

Aireon expects to be able to raise debt based on signed contracts with ANSPs, allowing it to make payments on hosting fees to Iridium. The company plans to eventually buy back shares from Iridium to restructure Aireon's ownership, giving Nav Canada a controlling 51% interest, Iridium 24.5%, Enav 12.5% and IAA and Naviair each 6%.

“We expect this to happen as early as 2021, when we are in operation and have the ability to raise debt to make those payments,” says Thoma.

It is not by coincidence that Aireon’s investors other than Iridium are ANSPs. “When we put this deal together back in the 2011-12 time period, it was very clear to us, given the length of time it takes to build space-based systems and the adoption rates of aviation just from a safety perspective, that financial investors were not appropriate for this type of project—their time horizons for investment were too short,” Thoma says. “This is where Nav Canada stepped in and said this has big strategic value to their operations in the North Atlantic and the northern parts of Canada.”

One apparent absence from Aireon’s lineup of participating ANSPs is the FAA, but Thoma asserts that the U.S. agency “has been a big supporter of this capability since the beginning” and has worked with Aireon under a memorandum of agreement since 2011. It was the FAA that rolled out a ground-based ADS-B network that informed Aireon’s system requirements, and also established a mandate for aircraft operators to equip for ADS-B “Out” position reporting by January...
Aireon maintains equipment to operate the hosted payloads at the Iridium satellite network operating center in Leesburg, Virginia. Its core business will be to sell air traffic control-grade surveillance data to ANSPs, a service it will manage from the Aireon Processing and Distribution (APD) Center that Harris runs on its behalf in Herndon, Virginia, near Washington Dulles International Airport. The APD facility is colocated with the operations center Harris runs for the FAA’s nationwide ground-based ADS-B system.

In September 2016, Aireon and FlightAware, of Houston, partnered to create a web-based aircraft tracking dashboard called GlobalBeacon that provides minute-by-minute position reports. Aireon supplies data from its space-based surveillance system; FlightAware provides the web interface and its own ground-based ADS-B tracking data. An airline subscribes to the service through FlightAware and pays a monthly fee per aircraft. Within days of unveiling their partnership, the companies announced that Qatar Airways was the first customer.

Driving an airline’s business case for GlobalBeacon is the International Civil Aviation Organization (ICAO) requirement that by this November aircraft be capable of reporting their position to airline operations centers no less than once every 15 minutes—the first step in establishing a Global Aeronautical Distress and Safety System (GADSS). By 2021, an aircraft in distress must autonomously transmit its position at least once every minute. GlobalBeacon already meets ICAO requirements, Aireon says.

ICAO developed the GADSS concept following the disappearance of Malaysia Airlines Flight 370 (MH370)—a Boeing 777-200—in the Indian Ocean in March 2014; and also in response to the loss of Air France Flight 447, an Airbus A330 that crashed in the Atlantic Ocean in June 2009 but was not found and recovered until nearly two years later.

**Thales Tests Aireon’s ADS-B Data**

**Thierry Dubois** Lyon, France

**THALES, WHOSE AIR TRAFFIC MANAGEMENT AUTOMATION SYSTEMS**

are widespread in air traffic control (ATC) centers around the world, has been testing Aireon’s automatic dependent surveillance-broadcast (ADS-B) data for almost one year.

A memorandum of understanding (MOU) was signed in 2015, Thales started work in March 2017, and “analysis is ongoing,” says Todd Donovan, vice president of strategy and marketing for air traffic management at Thales. The validation phase will continue through this year, as Iridium Next launches continue and the Aireon service is expanded toward its full operating capability.

Thales is independently validating the space-based ADS-B air traffic surveillance data, the two companies say. The collaboration includes “an assessment of technical performance, defining requirements associated with utilization of the data safely and with reliability,” engineers are focusing on the data’s update rate, availability, stability, coverage, latency and position accuracy. They are also studying the impact the service will have on existing operational processes.

The 2015 MOU was the first agreement signed between Aireon and an air traffic management automation platform provider.

For both companies, the partnership is of importance. For Aireon, associating Thales with the project means finding a distribution channel. That was one of the subjects of the MOU. It was devised “for Aireon data to be efficiently and effectively distributed to TopSky-ATC end-users,” the two companies say. TopSky-ATC is Thales’ offering in automation for en route and approach control centers.

Aireon wants to ensure that space-based ADS-B data into its TopSky-ATC offering in automation for en route and approach control centers.
Months after MH370 disappeared, Aireon said it would leverage its space-based system as a public service to provide the location and last flight track of a missing aircraft to ANSPs that do not subscribe to its data service as well as to airlines and search-and-rescue organizations. Investor IAA will manage the Aireon Aircraft Locating and Emergency Response Tracking service, branded as “Aireon Alert,” from its North Atlantic communications center in Ballygirreen, on Ireland’s west coast.

Thoma describes Aireon Alert as a “responsive, reactive” system that will be widely available. “There’s no subscription, there’s no payment,” he says. “What we have basically is a requirement that [potential users] preregister for security reasons [to ensure] we’re not giving data out to unregistered people.”

Last December, Aireon, Nav Canada and the FAA completed a second round of flight tests using aircraft fitted with top- and bottom-mounted antennas and 125-watt transponders—the minimum power output the FAA requires for ADS-B Out—to test the performance of Aireon’s receiver payloads on available Iridium Next satellites. (Another participant, Polaris Flight Systems, flew a Beechcraft Bonanza with a 200-watt transponder.)

While Aireon already monitors random ADS-B-signaling aircraft, or what it calls targets of opportunity, to perform large-scale sampling of the system’s performance, using flight-test aircraft in controlled scenarios allows the company to precisely measure system parameters, explains Capezzuto. “We’re doing edge-case testing; we’re trying to figure out where our break points are [with] calibrated testing,” he says. “This gives us the opportunity to sample with controlled inputs.”

One key parameter Aireon is measuring is update interval—the amount of time it takes to present an aircraft’s position on a controller’s screen. With a faster update rate, an ANSP potentially can reduce separations of aircraft flying outside of radar coverage. An Aireon system design criterion calls for supplying ADS-B position data at 8-sec. update intervals 96% of the time in low-density en route airspace—based on a European Organization for Civil Aviation Equipment specification for ADS-B systems. The update rate is aggregated from multiple ADS-B receivers seeing the same aircraft.

Flying its Bombardier CRJ200 flight-inspection aircraft in the Edmonton air traffic control zone over western Canada, with little interference from ground radars and other aircraft, Nav Canada recorded an ADS-B update interval of 2.8 sec. 95% of the time during the December testing.

The FAA flew its Bombardier Global 5000 flight-test aircraft from the Hughes Technical Center at Atlantic City International Airport, New Jersey, into New York oceanic airspace, in an area saturated with civil and military radars and aircraft with traffic alert and collision avoidance system transponders broadcasting in the same 1090 MHz frequency range used by ADS-B. The testing produced an update interval of 97 sec. This measurement represents a 25% improvement from initial test flights flown in March 2017, Aireon says.

The company emphasizes that the test results were derived in differing flight environments with only a fraction of the end-state satellite payloads actively receiving data. The next round of flight tests, planned for the second quarter, will have the advantage of a significant bandwidth increase. The mix of both first-generation and Iridium Next satellites produces the temporary limited bandwidth effect, the company says.

By monitoring random targets of opportunity—not flight-test aircraft—Aireon says it has logged update intervals of 3.36 sec. in Nav Canada’s Gander flight information region (FIR); and 2.87 sec. in IAA’s Shannon FIR, covering the western and eastern portions of the North Atlantic, respectively.

“We’re confident in achieving 8 [sec.] in U.S. airspace,” says Capezzuto. “After we complete the deployment, we will have a full constellation, full bandwidth capability and the adjacent receivers contributing to developing this information.”

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**Bernard Rosseau/Thales**

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The U.S.'s (Mostly Not) New Nuclear Policy

By James N. Miller

On Feb. 2, Defense Secretary Jim Mattis released the Trump administration’s Nuclear Posture Review (NPR) report. Three aspects of it are especially notable.

First, the new NPR is mostly not new. Mattis’s NPR reiterates the vast majority of the policy statements—and programmatic priorities—of the previous administration’s review.

Let’s be clear: Continuity is good. Bipartisanship is especially important, given the stakes involved with nuclear weapons.

The 2018 NPR mirrors closely the 2010 NPR in its declaratory policy. Both reviews sensibly state that the U.S. would use nuclear weapons only “in extreme circumstances to defend the vital interests” of the U.S. and its allies and partners. Both reports also reject explicitly the idea that deterring nuclear weapons use by others should be the “sole purpose” of U.S. nuclear weapons. Furthermore, the 2018 review reiterates verbatim the 2010 review’s commitment, aimed at potential proliferators, that the U.S. “will not use or threaten to use nuclear weapons against non-nuclear weapons states that are party to the [Treaty on the Non-Proliferation of Nuclear Weapons (NPT)] and in compliance with their nuclear non-proliferation obligations.”

On the programmatic side, the 2018 review follows the 2010 review in sustaining the U.S. strategic nuclear triad of ICBMs, submarine-launched ballistic missiles (SLBM) and heavy bombers. Like its predecessor, it also commits to sustaining nonstrategic nuclear weapons on dual-capable tactical aircraft. It also emphasizes investing in the key enablers of survivable nuclear command and control and the nuclear infrastructure overseen by the Department of Energy.

The second notable aspect of the 2018 NPR is that in the two main areas where it proposes new nuclear capabilities—a reduced-yield SLBM warhead and a new nuclear SLCM—are really needed. In fact, the Mattis 2018 NPR makes clear that the answer is: not necessarily.

Tweaking the ongoing life-extension program for the W-76 warhead to allow a few warheads with low yield will provide a near-term capability to bolster deterrence of the threat of Russian low-yield nuclear use. And it will do so in a way that is capable of penetrating increasingly advanced Russian air defenses. This near-term solution will plug a potential gap in deterrence for the decade or so before the air-delivered Long-Range Standoff missile can be deployed.

The 2018 NPR also makes clear that the plan to develop and deploy a new nuclear SLCM is in part a bargaining chip to increase U.S. leverage to bring Russia into INF compliance. Although a very good case can be made for going forward with deployment of a new nuclear SLCM, the reality is that the most the Trump administration can do is create a nuclear SLCM option for its successor—or perhaps its successor’s successor.

Which raises the third issue: Does the NPR represent the views of President Donald Trump?

While senior Pentagon leaders have emphasized continuity and restraint, the president has stoked fears by tweeting that he has a bigger nuclear button than North Korea’s leader, Kim Jong Un. Congressional concerns about the president have been serious enough to provoke a recent remarkable Senate Foreign Relations Committee hearing that considered whether (and potentially how) to restrict the president’s sole authority to employ nuclear weapons.

So, does the very reasonable Mattis NPR represent Trump’s views? At this point, we have to acknowledge that we just do not know. But, given the thoughtful and sensible approach taken in this NPR, we should certainly hope that it represents the policies of not only Mattis, but the president as well.

James N. Miller is president of Adaptive Strategies LLC and a senior fellow at the Harvard Kennedy School Belfer Center for Science & International Affairs. He served as undersecretary of defense for policy in the Obama administration. The views expressed are not necessarily those of Aviation Week.
The U.S.'s (Mostly Not) New Nuclear Policy

By James N. Miller

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