MAX Training
How Much More Is Needed?

South Korea's Civil Aerospace Ambitions

Germany's Lilium eVTOL Takes Off

Inside OneWeb's Satellite Factory

BizAv Market Update
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The U.S., Russia and China are turning their attention toward development and production of a new era of long-range strategic bombers. Defense Editor Steve Trimble’s report begins on page 36.
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CLARIFYING HISTORICAL PHOTO
I enjoyed “Maritime Threat” (May 6-19, p. 16), particularly the photo of one of Brig. Gen. Billy Mitchell’s demonstrations of the ability of aircraft to sink military ships—a military aviation milestone.

However, the photo shown is not of the bombing of the Ostfriesland in July 1921. Mitchell staged two more demonstrations, one in September 1921 and the other in September 1923. In the 1921 demonstration, the USS Alabama (BB8) was destroyed; the USS Virginia (BB13) and USS New Jersey (BB16) were destroyed in 1923. The photo that is reproduced is probably the bombing of the USS Alabama, identifiable by her cage masts and side-by-side funnels, features not found on the Ostfriesland.

Dane Ehrich, Webster, New York

CRACK THE CODE
Reader James R. French hit upon an issue that can plague software-controlled systems in any application (May 6-19, p. 5). Semi-conductor designers and manufacturers learned some time ago that proving the correct functionality of prototype new chips was not 100% reliable using software (SW) simulation alone because software code writers could not possibly think of everything when setting up the source code.

Chip designers quickly reverted to the time-honored method of checking functional operation via hardware (HW) simulations. However big the HW setups were, they worked because designers could, at much lower cost, actually check and alter until the correct operation was achieved.

The 737 MAX system failures evidently were due to some inadequate SW implementation. It is imperative that an alternative method of checking proper cockpit-system functionality be found.

David Green, Ontario, Canada

BOEING DEFENDER
Jens Flottau’s scathing comments on Boeing’s insistence that the initial design of its Maneuvering Characteristics Augmentation System (MCAS) was not flawed (May 6-19, p. 15) are premature. A formal report of the accident investigation has yet to be published, and there is some reason to believe that Boeing may be proved correct.

On previous 737 models the variable stabilizer had a purely trimming function, and its range of movement would have been decided by what was needed to trim the airplane throughout the allowable center-of-gravity (CG) range. For purposes that remain somewhat vague, Boeing elected to give MCAS partial authority over the stabilizer—but its angular movements are still constrained by the normal (trimming) limits and are small. If the claim were true that the stabilizer under MCAS control could overpower the pilot’s stick and elevator controls, that would imply an aircraft that the pilot was always unable to maneuver at some allowable CG position (with or without MCAS)—and that is patently false.

The flight-data-recorder outputs for Ethiopian Airlines Flight 302 (April 8-21, p. 29) seem to confirm that the crew were able to control the errant MCAS excursions until the system was inhibited (in accordance with Boeing instructions) and to fly the airplane manually for 1-2 min. thereafter—until the MCAS was unwisely, and inexplicably, reactivated and the crew lost control. Perhaps the crew was overly obsessed with a perceived need to trim the airplane, expecting the fault to have been transient, instead of reconciling themselves to some old-fashioned piloting and manually flying an out-of-trim airplane back to base.

Malcolm Bowden, McDonald, Tennessee

BOEING DISSIDENT
According to Boeing, a runaway trim is a feature, not a bug.

John Greenfield, Santa Fe, New Mexico

THE SKY IS FALLING . . . OR NOT
Reflecting on the responses to the Boeing MCAS situation by readers Jean-Claude Demiridjian and Guy Wroble (April 22-May 5, p. 5), I believe Demiridjian is spot on. Regarding a runaway stabilizer; it doesn’t matter what’s behind it; the fix has been the same since I started flying 737s 12 years ago, and I suspect since 1968: Flip the “stab cutout” switches to off, extend the manual trim handles, and fly the jet. Confusing at first? Yes, and a bit disconcerting, but this should not result in a crash.

Wroble’s response seems to play both sides of the court. First, he remarks that the 737’s systems are so outdated as to make one wonder how that aircraft stays safely airborne. Then he says it has grown so much as to make a common type rating questionable. The 757/767 fleet share a common type rating though the former is a narrowbody and the latter a widebody. Pilots have managed this for decades without fanfare.

Matt Marohn, Maple Lake, Minnesota

ONLINE, “An Optimized Twin—Flying The A330neo” (May 6-19, p. 38) generated discussion about Airbus’ new aircraft:

I Mizrahi notes:
The A330neo is a great airplane but its high price is a major deterrent to its commercial success.

Christopheretz counters:
Are there cheaper alternatives? I think orders will start to pick up as the A330ceos approach the end of their life.

jetdoc2@me.com points out:
Given the number of passengers it will hold, the price may not be too high. Surely Airbus and the airlines have done their economics homework.

Address letters to the Editor-in-Chief, Aviation Week & Space Technology, 2121 K Street, NW, Suite 210, Washington, DC, 20037 or send via email to: awstletters@aviationweek.com. Letters may be edited for length and clarity; a verifiable address and daytime telephone number are required.
Tino La Spina will take over as CEO of Qantas International Oct. 1, succeeding Alison Webster, who has retired. La Spina, the company’s chief financial officer, joined Qantas in 2006 from the National Express Group. Qantas Chief Customer Officer Vanessa Hudson will replace La Spina as CFO. Hudson joined Qantas in 1996.

Eric Beranger will become CEO of MRDA effective June 1, replacing Antoine Bouvier. Beranger was CEO of OneWeb from July 2016 to September 2018.

Boeing has named J. Michael Luttig to the newly created position of counselor and senior advisor to Boeing Chairman, President and CEO Dennis Muilenburg and the Boeing board of directors. Luttig served as general counsel since joining the company in 2006. He will be succeeded by Brett Gerry, who has been president of Boeing Japan since 2016 and before that was vice president and general counsel for Boeing Commercial Airplanes in Seattle.

The Dynamic Spectrum Alliance has appointed Martha Suarez as president. She was general director of The National Spectrum Agency in Colombia.

Coptersafety has named Erkka Suvikumpu as CEO. He was CEO and co-owner of Safera Oy.

Chris Herndon has joined HawkEye 360 as chief information officer. He was White House deputy assistant to President Donald Trump and director of White House information technology.

Pratt & Whitney has appointed Maria Della Posta as president of Pratt & Whitney Canada, effective June 1. She succeeds John Saabas, who will retire. Della Posta joined Pratt & Whitney in 1985 and held a number of leadership roles, most recently senior vice president at Pratt & Whitney Canada.

Thomas Vanec has been appointed vice president and managing director of Aeroenvironment’s new New England Innovation Center. He was vice president of InstantEye Robotics, a division of Physical Sciences Inc., and before that was general manager of Aurora Flight Sciences’ Cambridge Research and Development Center.

General Laserconics has selected Bruce Barbour as director of its global maintenance, repair and overhaul business. He was founder and chief operations officer of Commercial Laser Corp. CHC Group has appointed Carlos Madaleno regional director for Latin America, succeeding Marcelo Luiz da Silva Soares, who is retiring. Madaleno was sales director for Latin America.

Christopher Gryzmal has been promoted to chief financial officer of Nexello, the joint venture of Middle River Aerostucture Systems (MRAS) and Safran Nacelles. A 30-year MRAS veteran, he will continue as controller of MRAS and as the company’s site ombuds representative.

NanoRacks, a subsidiary of XO Markets, has hired Veronica La Regina as director of global engagement for Europe and director of NanoRacks Space Outpost, an Italian company collocated at ALTEC in Turin. She was a strategy and business development officer at RHEA Group and before that was a business innovation expert in the European Space Agency’s directorate of human and robotic exploration.

Robert Lightfoot has joined Lockheed Martin Space as vice president for strategy and business development. He served as NASA acting administrator as well as director of the Marshall Space Flight Center in Huntsville, Alabama, and director of propulsion test at Stennis Space Center in Mississippi.

Liquid Measurement Systems has announced a new leadership team: Director of Strategic Development Jonathan Farnham, Director of Finance Sarah Paxman-Bean, Director of Technology Mark Connors, Director of Operations Edward Killackey, Director of Human Resources Martha Hanson and Director of Government and Legal Affairs Greg Maguire.

HONORS & ELECTIONS

Lockheed Martin Chairman, President and CEO Marilyn A. Hewson received the 2019 Transatlantic Leading Edge Award from the Washington branch of The Royal Aeronautical Society for her leadership and contributions to the aerospace and defense industry, including advancing the U.S., UK and European technology relationship, during her 36-year career at Lockheed Martin, the last six as CEO. At the ceremony, the 2019 Fellowship Awards were presented to Eileen M. Collins, George London and Trish Beckman.

Collins, a retired U.S. Air Force colonel, was the first female space shuttle commander and logged more than 6,751 hr. in 30 different aircraft types as well as 872 hr. in space. She is an advisor to the National Space Council and on the board of the Astronaut Memorial Foundation. London, a former test pilot instructor at the U.S. Air Force Test Pilot School, flew more than 51 different aircraft and was chief test pilot on the C-17 program. He is a high school teacher and chief flight instructor at HJ Aviation. Beckman, the first woman to qualify as a crewmember on the F-15E and the first American woman to qualify as an F/A-18D crewmember, flew 67 different aircraft types in her 28-year U.S. Navy career and has logged more than 5,000 flight hours in 71 total aircraft types. She flies for Boeing Commercial Airplanes in Seattle.

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) 257-3682 outside the U.S.
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**DEFENSE**

Russia plans to purchase more modernized Tupolev Tu-160M2 strategic bombers, President Vladimir Putin said on May 13. Ten were ordered in 2018. “Ten more aircraft will be modernized. Maybe we will increase this number,” he said.

Sweden proposes strengthening its air force by retaining older Gripen fighters well into the 2030s rather than replacing the Saab JAS 39C/D model with the new Gripen E.

The U.S. Air Force is to reactivate the 65th Aggressor Sqdn. with Lockheed Martin F-35As, creating a stealthy adversary force for combat training at Nellis AFB, Nevada, in 2022.

Two of the UK’s five Boeing E-7 Wedgetail airborne early-warning aircraft will be converted from ex-airline 737-700s. Modification work will begin in 2021 under a $2 billion contract with Boeing.

Saab is to produce structures and systems for Boeing’s T-X trainer in West Lafayette, Indiana, and will use the new site as a springboard for developing products for U.S. and export defense markets.

Boeing has completed an initial series of wind-tunnel tests of a compound-helicopter concept for an advanced Apache, a proposed future upgrade of the AH-64E, aiming for an increased cruise speed of 185 kt. and range of 460 nm.

**COMMERCIAL AVIATION**

Toronto-based private equity firm Onex Capital will purchase Canadian low-cost carrier WestJet in an all-cash deal valued at C$3.5 billion ($2.6 billion). Including debt, the deal is valued at C$5.1 billion (page 24).

Startup Hermeus has secured seed funding from Khosla Ventures and private investors to develop a turbine-based combined-cycle propulsion demonstrator for its Mach 5 airliner, which it hopes will enter service within the next 10 years.

Flight tests of GE Aviation’s GE9X turbofan have been completed on the company’s Boeing 747-400 flying testbed ahead of the engine’s first flight this summer on the 777-9.

Mitsubishi Aircraft says a stretched, redesigned MRJ70 regional jet is a “realistic possibility” and is intended to be more competitive under current U.S. scope-clause restrictions.

The FAA has assembled a multiagency Technical Advisory Board to review the proposed software fix for the Maneuvering Characteristics Augmentation System implicated in two Boeing 737 MAX fatal crashes (page 22).

Poor weather, pilot error and mechanical failure are being investigated after an Aeroflot Sukhoi Superjet 100-95 crashed and burned on landing at Moscow’s Sheremetyevo International Airport on May 5, 27 min. after takeoff on a scheduled flight to Murmansk, killing 41 of the 78 passengers and crew on board.

The U.S. Senate has voted to confirm three nominees to the Export-Import Bank’s board of directors, enabling it to begin chipping away at its $40 billion backlog of deals awaiting approval (page 46).

Abu Dhabi-based Etihad Airways has bid for a minority stake in India’s Jet Airways, which suspended all flights in April after grounding more aircraft for missed lease payments.

Lufthansa has placed a nonbinding offer for Thomas Cook Group subsidiary Condor. The financially struggling tourism group decided earlier this year to put its airline division up for sale.

Inmarsat’s SwiftBroadband-Safety satcom service has received final FAA approval for air traffic services applications, allowing use for controller-pilot data link communications.

**Pentagon Space Plans Hit Hurdle**

When it comes to fighters, U.S. House of Representatives lawmakers are ready to provide billions for 90 Lockheed Martin F-35s, 12 more than the Pentagon has asked for, plus eight Boeing F-15EXs. But when it comes to the military’s plans for space, the House Appropriations defense subcommittee wants to see more homework.

The draft legislation, which would provide $690.2 billion for defense in fiscal 2020, reveals deep skepticism among lawmakers about plans for a Space Force and Space Development Agency (SDA).

If passed, the bill would withhold half of the funds needed for a new missile-warning satellite constellation until it is clear how the Air Force and SDA will work together. It would fund the refinement of Space Force plans—while making clear the money does not authorize establishment of a sixth U.S. military service.

But these controversies will likely be overshadowed by a partisan fight over the House’s rejection of President Donald Trump’s border-wall plan that has industry already preparing for stopgap defense funding based on 2019’s budget.
Think European, but Buy American?

Exhorted by President Donald Trump to spend more on defense, European officials are exasperated by U.S. reaction to a €13 billion ($14.5 billion) program to spur weapons development in the region.

Citing rules of the EU’s Permanent Structured Cooperation (PESCO) framework that prevents non-EU states from participating, U.S. officials have issued a veiled threat to further shut European nations out of U.S. defense programs.

But EU officials say their U.S. counterparts misunderstand the intent of PESCO, developed to increase cooperation between member states. “There is no ‘Buy European Act,’ and around 81% of international contracts go to U.S. firms in Europe today,” says European Commission official Federica Mogherini.

EU member-states are preparing a “clear and complete” reply to Washington’s concerns, and they will decide in June on what basis non-European firms can take part in PESCO, which is funding programs such as the EuroMALE UAV being developed by France, Germany, Italy and Spain.

Test firings are planned this summer for the 10,000-lb-thrust liquid-oxygen/liquid-hydrogen BE-7 engine for Blue Origin’s Blue Moon lunar lander. Amazon founder Jeff Bezos unveiled a full-scale mockup of the 6,500-kg-payload (14,300-lb.) lander on May 9 (page 30).

German startup Lilium has completed the maiden unmanned hover flight of its Lilium Jet five-seat electric vertical-take-off-and-landing (eVTOL) aircraft. The full-size prototype has 36 tilting ducted fans on tandem wings (page 20).

Airbus’ CityAirbus ducted-rotor eVTOL urban air mobility demonstrator made its first tethered hover flights at Donauworth, Germany, on May 1. Airbus’ Vahana tiltwing eVTOL demonstrator completed its first full transitions between vertical and forward flight on May 3.

Bristow Group has joined a growing list of offshore helicopter operators to enter Chapter 11 bankruptcy protection to restructure its operations. The Houston-based company operates nearly 300 aircraft.

Europe was recovering from World War II and the Cold War was underway when the Paris Air Show convened in May 1949 at the glass-domed Grand Palais off the Champs-Elysées, with flight demonstrations held at Orly Field. The star of the show: the Leduc 0.10, an experimental, ramjet-powered “piggyback” aircraft that had made its first flight just days earlier (top left image). “The 0.10 is just a flying stovepipe with five burners.” Aviation Week reported in an “extensive exclusive report” on the show that ran in our May 23, 1949, edition. “It is three times lighter than comparable turbojets.” French officials said the aircraft’s cruising speed was 550 mph at 50,000 ft. “Informal reports from the pilot after the first test flight indicate that the ship is capable of doing nearly twice that,” they added. The show had been held at the Grand Palais since 1909, but after four decades it was overflowing the ornate venue. The event was moved to Le Bourget Airport in 1953, where it will be held this year in June.

Subscribers can read the May 23, 1949, edition of Aviation Week and every issue back to 1916 at: archive.aviationweek.com
COMMENTARY

UP FRONT

KEVIN MICHAELS

THE BOEING 737 MAX SITUATION

reminds us that jetliner groundings, while rare, have always been with us. In 1979, the FAA grounded the McDonnell Douglas DC-10 following concerns that a weak left engine mount had caused the crash of an American Airlines flight in Chicago, killing 273 people. This followed a 1974 Turkish Airlines DC-10 crash with 346 fatalities, thanks to a faulty cargo door design. Dogged by high fuel burn and a perception that it was operationally unsafe, McDonnell Douglas terminated production in 1983.

Today’s grounding of the 737 MAX is fundamentally different. While the DC-10 comprised 5% of the jetliner fleet when it left production, the 737 accounts for 30% and is a workhorse of the airline industry. The DC-10 was a subpar design, while the 737 is “not a flawed product. It is a good product with a flaw inserted inside it,” says Bank of America Merrill Lynch’s Ron Epstein.

The most significant difference, however, is in media. Newspapers and television were the dominant media channels reporting the DC-10’s maladies. Communication was sporadic. Public opinion was formed locally and was not organized. Today, social media dominates. Facebook boasts 2.3 billion users, YouTube 1.9 billion and China’s WeChat 1 billion. The U.S. president makes major policy announcements on Twitter, where he has 60 million followers, and some 45% of Americans get their news from Facebook. Hashtags can morph into trending topics, which can then gush into Facebook and Twitter feeds all over the world.

Social media has been a force in aviation for just over a decade. In 2009, it documented the “Miracle on the Hudson” and helped make Capt. Chesley Sullenberger a national hero. In April 2017, a video of the brutal removal of a passenger from United Airlines Flight 3411 went viral globally, thanks to the passenger’s Chinese-Vietnamese ethnicity. On Sina Weibo, China’s top microblogging site, more than 95 million users read a critical review of the incident. In April 2018, social media spread the news of an engine failure and passenger fatality on Southwest Airlines Flight 1380. In response, Southwest suspended advertising and suffered a 3% quarterly revenue decline.

Social media may have played a role in the FAA’s decision to ground the MAX shortly after similar moves by other regulatory agencies, too. Traditionally, decisions to return grounded aircraft to service included three actors: regulatory agencies, OEMs and airlines with input from their unions. Social media has thrust public opinion into the mix. This has caught Boeing—used to controlling the message and communicating discretely with regulators and airlines—flat-footed in its messaging to the public. Rather than accepting immediate responsibility and promoting its plan to fix the Maneuvering Characteristics Augmentation System (MCAS) after the October 2018 Lion Air Flight 610 crash, it remained relatively quiet and seemed to focus blame on the customer.

It has yet to offer a convincing explanation as to why the MCAS was designated a non-flight-critical system and was dependent on a single sensor, or why it failed to notify pilots of its existence. And we just learned that it did not tell U.S. regulators and customers for more than a year that that the angle-of-attack Disagree alert did not function properly for many MAX operators. Rather than opening up, Boeing appears to be “lawyering up.”

This approach is at odds with the transparency demanded by social media, and Boeing is facing the wrath of global public opinion. In the week following the Ethiopian Airlines Flight 302 crash, at least 870,000 tweets were posted about the 737 MAX, with a majority trending negative. It is difficult to quantify the damage to Boeing’s reputation, but early results are not encouraging. An online poll by The Air Current with an aerospace-centric survey sample of 6,700 found that 48% would not feel comfortable flying on the 737 MAX when it returns to service. I suspect the number would be higher with the general public outside the U.S.

This means non-U.S. regulators such as the European Aviation Safety Agency and the Civil Aviation Administration of China will be in no rush to return the MAX to service. It must also receive the green light from nervous airlines, which may cancel orders or delay its reintroduction into their fleets. Virgin Australia just decided to delay its deliveries by two years, and major MAX customer FlyDubai is considering the Airbus A320neo as an option. Even airlines confident in Boeing’s ability to implement a fix may leverage the company’s weakened position to renegotiate commercial terms or reduce orders.

It is clear that in addition to flawless reintroduction of the MAX, Boeing needs to adapt to the reality that social media is driving messaging and public perception. It needs to embrace #transparency.

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

#TRANSPARENCY

Social media is Boeing’s Achilles' heel

STEPHEN BRASHEAR/GETTY IMAGES

Contributing columnist Kevin Michaels is managing director of AeroDynamic Advisory in Ann Arbor, Michigan.
It is clear that in addition to flawless reintroduction of the MAX, Boeing needs to adapt to the reality that social media is driving messaging and public perception.

Commercial airlines have a fawed impression of Boeing. It needs to embrace transparency.

Aerospace is Boeing’s new name for trusted, mission-critical systems and services. It offers the world’s most comprehensive aerospace and defense product line. It is a good product with a flaw inserted inside it,” says Bank of America Merrill Lynch’s Ron Epstein.

People still remember the DC-10. It was a decade. In 2009, it documented the “Miracle on the Hudson” and helped make Capt. Chesley Sullenberger a national hero. In April 2017, a video of the brutal removal of a passenger from United Airlines Flight 3411 went viral globally, thanks in part to the passenger’s characterization as a “lawyering up.”

Social media is Boeing’s channel to the world. Social media is driving messaging and public perception. Rather than opening up, Boeing appears to be “lawyering up.” Rather than accepting immediate change, Boeing continues to blame on the customer.

The most significant difference, however, is in media. Today’s grounding of the DC-10 comprised 5% of the news in the United States. That was sporadic. Public opinion was formed locally and was not organized. Today, social media dominates. The most trending #TRANSPARENCY trends on Twitter feed into Facebook and trending topics, which can then gush into Facebook and Twitter, which can then gush into Twitter feeds all over the world.

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Hashtags can morph into Facebook trending topics, which can then gush into Facebook and Twitter, which can then gush into Twitter feeds all over the world.
AviationWeek.com/awst

COMMENTARY

GOING CONCERNS

MICHAEL BRUNO

THE SPECTER OF CHINA OPTING
to forgo Boeing airliners or other U.S. aerospace products is reemerging now that the countries are set to raise tariffs on each other’s imports following a breakdown in trade talks May 10.

Nothing has changed about the benefit or harm to either side of such a boycott, or the timing and details, but aerospace cognoscenti had conveniently forgotten about such possibilities until recently because both sides made it sound like a deal was imminent. Last year, both countries appeared to largely exclude commercial aviation from their targeted penalties. Also, the 737 MAX groundings, delivery halt and production slowdown are exigent crises.

But with a new impasse looming, there is a need to ratchet up trade tensions, according to self-proclaimed experts such as U.S. President Donald Trump. In turn, the potential cost to commercial aerospace is being re-examined. Commercial aircraft, engines, equipment and parts top the list of U.S. products exported to China, along with soybeans, according to the U.S. Census Bureau.

“Boeing represents a high-value target for the Chinese, and the 737 MAX grounding could not have come at a worse time for Boeing and the industry,” says Canaccord Genuity analyst Ken Herbert. He notes that the Chinese newspaper The Global Times, considered a mouthpiece of the Communist Party, warned that Beijing may force a reduction in orders for U.S. products. Bloomberg Intelligence says Chinese airlines have fueled an average of 7% higher revenue and 11% more profit per year at Boeing in the last decade.

But the relationship goes both ways, meaning any Chinese retribution would be felt at home. “China can’t place punitive tariffs on Boeing aircraft without harming Chinese airlines,” say Bloomberg aerospace analysts George Ferguson and Francois Dufot. “Any immediate tariffs imposed would likely be paid by airlines, most of them state-owned.

“Ceding future orders to Airbus would also drive up prices,” they continue. “China could skew orders toward Airbus, though right now there are plenty to go around. In the event Airbus’ backlog becomes too large, Boeing could offer the benefit of faster deliveries. Production rates can’t be quickly boosted to capture more share, with planned increases after 2019 set for 2021 when Airbus rises to 63” A320 aircraft produced a month.

Dicey Times Ahead
U.S./China trade tensions mount

While all the analysts agree it would be difficult for China to just choose Airbus over Boeing going forward, they also agree that China continues to have leverage in the MAX recertification issue and could use it to send signals to Washington (and Boeing).

There are other signals, as well, and through them it is suppliers that seem more vulnerable. The Bloomberg analysts note how aluminum and steel are key raw materials used in aircraft production, including skins, structures and high-strength components.

“Aluminum and steel import tariffs could crimp aerospace suppliers’ margins, though the effects should be largely mitigated by long-term pricing contracts and by passing costs to OEMs, mostly Boeing and Airbus,” they say. “Tier 1 suppliers such as Spirit AeroSystems, Triumph and United Technologies appear most exposed. Any cost pressures could heighten near- and longer-term margin risks for the group, given intensifying OEM price pressure on suppliers.”

Unfortunately, things seem to be getting worse. “While we see little near-term risk associated with the Boeing exposure to China, it is difficult to handicap now what is just negotiations and what is a real risk to the sector,” says Herbert.

That means China remains a risk to commercial aerospace for the near term, and maybe even longer. With every escalation between Beijing and Washington, industry runs out of that much more proverbial runway. Perhaps it is time to reconsider counting on China’s growth; soon industry might not have a choice.

Boeing Backlog With Chinese Operators

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Sources: Company reports, Cirium, Canaccord Genuity estimates

THE SPECTER OF CHINA OPTING
to forgo Boeing airliners or other U.S. aerospace products is reemerging now that the countries are set to raise tariffs on each other’s imports following a breakdown in trade talks May 10.

Nothing has changed about the benefit or harm to either side of such a boycott, or the timing and details, but aerospace cognoscenti had conveniently forgotten about such possibilities until recently because both sides made it sound like a deal was imminent. Last year, both countries appeared to largely exclude commercial actions due to their higher relative dependence on China for revenue. Boeing, Intel and Texas Instruments each receive more than 20% of annual revenue from China. Bloomberg Intelligence says Chinese airlines have fueled an average of 7% higher revenue and 11% more profit per year at Boeing in the last decade.

But the relationship goes both ways, meaning any Chinese retribution would be felt at home. “China can’t place punitive tariffs on Boeing aircraft without harming Chinese airlines,” say Bloomberg aerospace analysts George Ferguson and Francois Dufot. “Any immediate tariffs imposed would likely be paid by airlines, most of them state-owned.

“The specter of China opting to forgo Boeing airliners or other U.S. aerospace products is reemerging now that the countries are set to raise tariffs on each other’s imports following a breakdown in trade talks May 10,” says Canaccord Genuity analyst Ken Herbert. He notes that the Chinese newspaper The Global Times, considered a mouthpiece of the Communist Party, warned that Beijing may force a reduction in orders for U.S. products. Bloomberg Intelligence says Chinese airlines have fueled an average of 7% higher revenue and 11% more profit per year at Boeing in the last decade.

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“Ceding future orders to Airbus would also drive up prices,” they continue. “China could skew orders toward Airbus, though right now there are plenty to go around. In the event Airbus’ backlog becomes too large, Boeing could offer the benefit of faster deliveries. Production rates can’t be quickly boosted to capture more share, with planned increases after 2019 set for 2021 when Airbus rises to 63” A320 aircraft produced a month.

Dicey Times Ahead
U.S./China trade tensions mount

While all the analysts agree it would be difficult for China to just choose Airbus over Boeing going forward, they also agree that China continues to have leverage in the MAX recertification issue and could use it to send signals to Washington (and Boeing).

There are other signals, as well, and through them it is suppliers that seem more vulnerable. The Bloomberg analysts note how aluminum and steel are key raw materials used in aircraft production, including skins, structures and high-strength components.

“Aluminum and steel import tariffs could crimp aerospace suppliers’ margins, though the effects should be largely mitigated by long-term pricing contracts and by passing costs to OEMs, mostly Boeing and Airbus,” they say. “Tier 1 suppliers such as Spirit AeroSystems, Triumph and United Technologies appear most exposed. Any cost pressures could heighten near- and longer-term margin risks for the group, given intensifying OEM price pressure on suppliers.”

Unfortunately, things seem to be getting worse. “While we see little near-term risk associated with the Boeing exposure to China, it is difficult to handicap now what is just negotiations and what is a real risk to the sector,” says Herbert.

That means China remains a risk to commercial aerospace for the near term, and maybe even longer. With every escalation between Beijing and Washington, industry runs out of that much more proverbial runway. Perhaps it is time to reconsider counting on China’s growth; soon industry might not have a choice.

AviationWeek.com/awst
COMMENTARY

Sources: Company reports, Cirium, Canaccord Genuity estimates

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The specter of China opting to forgo Boeing airliners or other U.S. aerospace products is reemerging now that the countries are set to raise tariffs on each other's imports following a breakdown in trade talks May 10. As China's growth continues and industry might not have a runway. Perhaps it is time to reconsider counting down are exigent crises.

Unfortunately, things seem to be getting worse. With every escalation between Beijing and Washington (and Boeing), there is a need to reevaluate the risks for the industry. While all the analysts agree it would be difficult for China to just choose Airbus over Boeing going forward, they also agree that China continues to have leverage with planned increases after 2019 set for 2021 when Airbus, though right now there are plenty to go around.

To learn more about customized solutions to meet your specific needs, visit pages.aviationweek.com/IntelFleetData or call Anne McMahon at +1 646-291-6353 or Thorn Clayton +44 (0) 20 7017 6106.
IN MID-MARCH, AIRBUS’ ZEPHYR solar-powered, high-altitude unmanned aircraft encountered severe weather while en route to the stratosphere and crashed close to its launch site in remote Western Australia.

The incident underscores the challenge of opening the upper atmosphere to routine operations by very large but very light platforms such as Zephyr that can stay aloft for weeks or months to provide persistent communications or surveillance.

During the Xponential unmanned-systems show in Atlanta a few weeks later, officials from three of the companies developing “high-altitude pseudo-satellites” (HAPS)—Airbus Defense and Space, Aurora Flight Sciences and BAE Systems—agreed there is no substitute for flight experience when it comes to developing stratospheric aircraft.

No surprise, therefore, that HAPSMobile—the joint venture between AeroVironment and Japan’s SoftBank that is developing the Hawk30 unmanned aircraft to provide internet connectivity from 65,000 ft.—is also partnering with Loon. Balloons operated by Loon, a subsidiary of Google parent Alphabet, have already logged more than 35,000 km (22,000 mi.) in the stratosphere carrying LTE broadband payloads.

With Loon, HAPSMobile plans not only to develop common ground stations and communications payloads for the free-flying balloons and the 256-ft.-span Hawk30 but also to draw on the company’s experience managing a fleet of high-flying autonomous platforms.

The March accident a few hours into the Zephyr’s customer demonstration flight from Airbus’ operating base in Wyndham, Western Australia, was a setback. But the company is sticking to its plans to at least double its flight experience, now 1,600 hr., by year-end. “This is not an easy game. You need to understand the physics and the environment,” says Nigel Chandler, head of sales for Zephyr.

Another three of the 82-ft.-span, 170-lb. gross-weight Zephyrs are based at Wyndham and, with Australia’s Civil Aviation Safety Agency, Airbus is working to gain approval for a single operator to manage multiple air vehicles simultaneously.

Airbus is ahead of its direct competitors in flight experience, including completing an almost 26-day flight in 2018. Boeing company Aurora plans to fly its 243-ft.-span Odysseus this year; and UK company Prismatic, with BAE, hopes to fly its 115-ft.-span PHASA-35 by the end of 2019 or early in 2020, says Martin Topping, international production director for BAE’s air sector.

AeroVironment has assembled the first Hawk30, and HAPSMobile intends to begin production and commercial operations in 2023. The aircraft is designed to operate year-round at latitudes from 30 deg. north to 30 deg. south of the equator. The joint venture has already begun developing the next-generation Hawk50, which will be able to operate at latitudes 50 deg. north and south of the equator, covering Japan and North America, says HAPSMobile CEO Junichi Miyakawa.

Orbiting at 65,000 ft., the Hawk30 will act as a flying cell tower, providing 4G LTE and 5G connectivity direct to mobile devices over an area 200 km in diameter. Approximately 40 aircraft could cover the entire Japanese archipelago, he says. Aircraft will be interoperable with terrestrial cell towers, expanding coverage, and with low-Earth-orbit satellites operated by OneWeb, in which SoftBank is an investor. OneWeb’s satellites cannot provide links directly to devices, Miyakawa says, but will provide backhaul communications to the aircraft, which will then provide direct services to users.

The Hawk30 is designed to stay aloft for six months, compared to 3-4 months for Zephyr and a year for PHASA-35. Loon’s balloons average 150 days aloft before being recovered, and it is working toward 300 days, says CEO Alastair Westgarth. Once aloft in the stratosphere, the balloons exploit winds flowing in different directions at different altitudes to circle a service area, millimeter-wave links on each payload connecting teams of balloons to provide service to a region. Loon provided connectivity to Puerto Rico after Hurricane Maria destroyed the island’s communications infrastructure in 2017.

All the companies in the emerging HAPS sector see the same markets: providing broadband connectivity to remote or developing regions, restoring communications after a disaster or enabling persistent surveillance—with greater flexibility and a cost orders of magnitude lower than a geostationary satellite. But these vehicles are still in their infancy. “We are so close to the boundaries of what can be manufactured,” says Topping. They are fragile, but as experience grows and technology improves they look set to become essential.
Dress Rehearsal
Apollo 10’s practice run paved the way for lunar landing

The Moon and stop 9 mi. short of the mark? But LM contractor Grumman Aircraft Engineering—predecessor to Northrop Grumman—was still shaving weight from the LM, so unless NASA wanted to delay the flight, there was not enough time to switch out Apollo 10’s heavier descent module, nicknamed Snoopy, for what would become Apollo 11’s Eagle.

Also, flight controllers were not sure how the Moon’s lumpy gravity field would affect lunar-orbiting spacecraft. They wanted more data from an Apollo 10 flight test to improve the odds that the lander’s ascent section could rendezvous and dock with the command module after the lunar-surface mission.

On May 18, 1969, Apollo 10 Cmdr. Thomas Stafford, pilot John Young and LM pilot Eugene Cernan strapped themselves inside their Apollo capsule (nicknamed Charlie Brown) and lifted off aboard the behemoth Saturn V rocket from Launch Complex 39B at what was then known as Cape Kennedy, in Florida. Apollo 10 was the only Saturn V to fly from 39B, as Pad 39A was being prepared for Apollo 11 in July.

Stafford, Young and Cernan were NASA’s most experienced crew to date, with five Gemini flights among them. Their mission was to practice the flight plan developed for Apollo 11’s Moon-landing mission by colleagues Neil Armstrong, Michael Collins and Buzz Aldrin, scheduled for just two months later. The only thing the Apollo 10 crew would not do was conduct a final descent burn of the LM to touch down on the lunar surface.

After a 2.5-hr. systems checkout in low Earth orbit, the third stage of the Saturn V fired up for 343 sec. to send the spacecraft on a trajectory that would reach lunar orbit. After a 73-hr. ride, Snoopy, then docked with the LM, slipped into orbit around the Moon.

The next day, Stafford and Cernan floated into the LM, activated its systems and undocked. Snoopy first flew in tandem with Charlie Brown, orbiting about 70 mi. above the lunar surface, while Young, alone in the command module, conducted a visual inspection of the LM.

Snoopy’s descent engine then fired for 27 sec., with the burn timed so that the LM would make its closest approach to the Moon within 15 deg. of one of the primary Apollo 11 landing sites. Stafford and Cernan whizzed past the lunar landscape, traveling at 3,740 mph—more than five times the speed of sound—snapping pictures and testing the landing radar.

A second burn, which replicated a powered ascent from the lunar service, positioned the LM for a rendezvous with the command module, setting the stage for the return trip to Earth.

The capsule splashed down in the Pacific Ocean at 12:52 p.m. EDT on May 26, completing a 61-orbit lunar mission and paving the way for Apollo 11 to lift off seven weeks later.
First announced by Rolls in 2014, the shift to the geared-engine architecture remains the company’s No. 1 priority for its long-term future gas turbine development plan and, offering a 25%-plus efficiency improvement over the Trent 700, it will be available in the second half of the 2020s. Although the UltraFan development timetable was close to Boeing’s 2025 initial service-entry target for the NMA, Rolls dropped its bid on Feb. 28 after acknowledging an unacceptable schedule risk (AW&ST March 11-24, p. 14). The engine concept, which is scalable for use on both single- and twin-aisle aircraft, is therefore currently without a specific application, although Rolls says discussions with manufacturers on unidentified projects are underway.

Through the remainder of 2019, the focus remains on an accelerating series of key demonstrator and rig tests that will pave the way for ground tests of the initial UltraFan in 2021. Central to the plan is the Advance3, which is evaluating the new high- and intermediate-pressure (IP) core architecture. Sandwiched between the fan and low-pressure (LP) compressor of a Trent XWB and the LP turbine of a Trent 1000, the hybrid engine core is “the best demonstrator we have ever done,” says Phil Curnock, chief engineer for civil future programs at Rolls-Royce. “It started the first time, and that means a lot because sometimes that’s not easy,” he says. The core is designed to prove the fundamental architecture change at the heart of the UltraFan, which puts additional work through the high-pressure spool and less through the IP compared to current Trent engines. The Advance3 is also the first large-scale engine demonstrator to have been designed using the digital technologies in the company’s IntelligentEngine initiative. As such, it is also the first to incorporate a “digital twin” version, on which engineers can virtually test performance models for comparison with the real thing.

More than 100 hr. have been accumulated on the test engine, which has been a “seamless demonstrator of what we intended to do and produced all the data we wanted,” says Curnock. Phase One, which saw the engine run to full power, was completed by early 2019. “We got literally millions of data points, and one of the reasons between the two test phases is that we have been taking time to analyze the data. It will go back on test later this year, and we will do more aggressive testing, including rapid transients and water-ingestion testing,” he adds.

Advanced material and component technology, particularly ceramic matrix composites (CMC) and improved...
metallic cooling, continue to be tested in the Trent XWB-97-based HT3 (high-temperature turbine technology) demonstrator. “That’s taking us to the next level in terms of HP turbine technology,” says Curnock. Specific test items include CMC seal segments and more intricate cooling passages in the turbine developed using the company’s CastBond manufacturing process.

As the fan on the new engine will be driven by a power drive gear system connected to the IP spool, the UltraFan does not require a large LP turbine like that on existing Trent models. The change, however, means additional load for the IP turbine, which is an enlarged four-stage unit incorporating titanium aluminate blades. “There’s been a series of IP turbine rigs, and there’s another one coming this year.

The rig tests will help verify the models and give us confidence to go to the full-up demonstrator,” says Curnock. Rolls is also rebuilding a Trent 1000 demonstrator for evaluation of the latest iteration of the advanced low-emissions combustor system (ALECSys) in 2020 on the company’s Boeing 747-200 flying testbed. “It’s a system; people often think lean burn is just different parts of the combustor, but you need the valves and the control system and test it in the environment. [It can do] much more than a different combustor can,” observes Curnock. A version of the ALECSys lean-burn system is also running in the Advance3 engine. “So that’s been tested with the new and current Trent core architecture,” he adds. The clean combustor demonstrator, which is supported by Europe’s CleanSky research initiative, also completed a rigorous set of ice- and water-ingestion tests in Canada last winter.

In conjunction with the other demonstrators, Rolls has also been ground-testing a modified Trent 1000 with both the fan blades and fan case made from composite material, marking the final phase of the Advanced Low-Pressure System (ALPS) technology demonstration program. ALPS results will feed directly into the UltraFan demonstrator fan, the design of which will be guided using aerodynamic data collected over a series of subscale low-speed fan rig tests conducted at the Anecom facility in Wildau, Germany.

Low-speed aerodynamic testing was recently undertaken at Anecom on a 35-in.-dia. metallic fan stage with blades shaped like the composite design. Testing on the blades—the fifth generation of the design—including flutter, aerodynamic performance and operability margins of various fan configurations.

More than 250 hr. of run time have also been amassed on the power gearbox in the attitude and power rigs in the company’s Dahlewitz, Germany, facility. “The fifth one was recently on test, and as we have shaken down the fundamental design, the focus now starts to turn to endurance and reliability. Now it’s about how it handles life experience,” says Curnock.

The gear system is the largest ever developed for an aerospace application, and measuring some 2.6 ft. (80 cm) in diameter, it is sized to power higher-thrust versions of the approximately 25,000-110,000-lb.-thrust-class UltraFan family. The planetary style gearbox, developed by Aerospace Transmission Technologies, is a joint venture formed in mid-2016 by Rolls-Royce and Liebherr-Aerospace, consists of a ring gear on the outside and five planet gears inside rotating around a central sun gear. Unlike the star-style gear system used by Pratt & Whitney, in which the fan is attached to the outer-ring gear, the Rolls design drives the fan off of the centrally mounted planet carrier.

“As the initial demonstrator will be in the 80,000-shp range, this [larger] gear size enables us to do over-torque testing,” says Curnock. “The rig can be configured to different sizes, but we have learned through generations
of the same size. Most of it has been subtle differences, but they have all had five planets and one sun [gear], and we can play with where we inject oil or take it out.

“The subtlety of how to manage the oil and heat is pretty complex, and that’s what we have been tweaking and playing with as well as adding loads,” he notes. “That’s teaching us about how it responds and how gear wears. We have learned about the fundamentals of the gearbox, and now we have to push it a bit further in terms of pressures, temperatures and environment.”

**RISSING CATHEDRAL-LIKE INTO THE SKIES OF ROLLS-ROYCE’S**

Lofty Test Bed 80 will be the company’s most capable indoor evaluation facility and, sized for engines of up to 140,000 lb. thrust, a concrete testament to its belief in the promise of the next-generation UltraFan family.

Unlike the hundreds of years it took to complete the medieval cathedrals of Europe, Rolls’ latest engineering monument will be commissioned by mid-2020, just over two years after construction began and three years after the start of initial design. Involving 3,450 tons of steel and 27,000 m³ (290,525 ft.³) of concrete, the 80,730-ft.² facility will be the largest of its type in the world.

The vast volume of concrete is needed partially because the $190 million testbed has double walls up to 8.9 ft. (2.7 m) thick. “That’s for acoustic protection, and you shouldn’t hear anything being tested inside out on the road at all,” says Wayne Selway, site project manager for Canadian prime contractor MDS Aero Support. Working with Buckingham Group Contracting on the construction, MDS is responsible for all aspects of the overall project, ranging from design and management to supply of test systems, engine adapters, support systems and data acquisition and control.

“The other big thing about this testbed is the ability to test the engine with a huge X-ray device while it is running,” says Selway. “I haven’t seen that done anywhere else before. Rolls has retrofitted another of the testbeds (57) to do that, but that was more for one-off use, and this is purpose-designed to allow for repeated testing. The wall thickness is based on X-ray requirements. You can protect from external emissions with about 30 cm (11.8 in.) of lead or the equivalent density in concrete, which gives you 2.7-m thickness,” he says. The resulting structure has a 5.6-ft. interior wall and 3.3-ft. exterior wall to give the combined amount.

The X-ray system enables test engineers to run the engine and visualize the position of seals and clearances in real time. “From our point of view, it will be our most capable bed,” says Adrian Stanley, Rolls-Royce technical project manager for test systems. “Although most of them today can do several tests from a development perspective, this one will allow us to do every test you can think of, so it will give us more flexibility.”

With an overall length of 426.5 ft. and an internal enclosed space 49 ft. tall by 49 ft. wide, the building is dominated by the 95-ft.-tall intake tower at its north and 123-ft.-tall exhaust stack at the south. “The design weight for the floor and test platform is 66 tons . . . to handle the engine and its carrier with very small wheels,” says Selway. “That means the point load is quite high, and that’s why we have such a big slab. The concrete structure should be finished by the early August time frame.”

Designers faced the challenge of managing unprecedented volumes of airflow and energy inside the test cell. “It’s bigger than our other testbeds, because it has got to be able to take in enough air for testing engine performance, and just as important for testing N₂ [engine core speed] is the quality of air coming through the bed,” says Gareth Hedicker, director of development and experimental engineering for Rolls-Royce Civil Aerospace.

“So, we have gone deliberately large to get good mass flow through the bed and really smooth air along it,” says Hedicker. “The other trick is managing the flow out of the back. One of the big things is the amount of kinetic energy that can build up in the exhaust. We have to get it out without affecting the engine, as well as without noise and vibration. Producing a design that will last 30 years doing that has been quite a challenge.”

From the initial design phase, Rolls worked closely with MDS, which has also developed test facilities for other engine-makers including Pratt & Whitney. “Rather than us doing the specifications and MDS doing the design, we took the decision together to develop a standard that we can then use to retrofit older beds or build new ones going forward,” Hedicker says.

Commissioning will take place around mid-2020. “A lot of that will be done without an engine installed because, one, we have to get all the control systems talking to each other. Then we will bring in an engine, probably a Trent XWB, to do that,” says Stanley.
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At the Conference, Delegates will meet face-to-face with industry peers and develop a valuable network of industry experts, as well as gain knowledge and updates enabling them to adjust business plans and strategies in this dynamic industry.
As the number of would-be electric vertical-takeoff-and-landing (eVTOL) concepts continue to proliferate, Germany-based Lilium has stepped ahead of the wave by starting test flights of a full-scale, five-seat production-weight prototype.

Designed to fly at up to 300 kph (165 kt.) for 300 km (186 mi.), at higher speed and range than most of the other urban air mobility (UAM) eVTOLs in development, the Lilium Jet is positioning its offering for intercity and urban missions. To achieve this performance, the battery-powered vehicle incorporates an unusual combination of canards and a fixed wing with arrays of electric ducted fans.

Unveiling new details about the Lilium Jet shortly before the May 4 first flight of the full-scale vehicle, company CEO and co-founder Daniel Wiegand says others “like Bell and Uber are talking about urban mobility with local flights in a metropolitan area with flights of maybe up to 50 km.” He notes, “What we have in mind is something with a bigger range and an ability to service two markets—the metropolitan area and an intercity market.”

The chief innovation on the vehicle is an integrated propulsion and lift system, which comprises 36 electrically driven ducted fans mounted on 12 tilting flaps. Three are clustered per flap for a total of 12 fans on the trailing edges of the canard and 24 on the wing. The flaps tilt down for vertical lift and aft to provide thrust in forward flight, enabling the vehicle to rely on the lift generated by the fixed wing, thereby using less than 10% of its maximum 2,000 hp during cruise flight.

Flight control is achieved by varying the thrust angle and rpm of the flap-mounted fan sets via a triple-redundant flight-control system (FCC). The thrust angle is driven by actuators, with one actuator and gearbox per set. “All actuators are completely independent so they have their own buses, power circuit and gearbox, but the control law treats them in a standard way as long as none of them fail,” says Wiegand. “If an actuator fails, it is switched off, and the FCC changes to a different control law which is optimized for controlling the plane without it.

“We looked at all kind of tiltwings, but the best one we found is the configuration we have developed over the past three years,” he says.

Flight tests of an initial two-seat demonstrator in 2017 quickly showed the benefits of the design, Wiegand adds. “For example, it took us about three months to fly the aircraft in full transition [with fans ducted fully aft and then back to vertical-lift mode], as well as flying circles in transition and flying 45-deg. bank angles and so on. It took others about two years to get to that point. That is not because they’re not smart; it is just because some of their designs are maybe not ideal to fly these maneuvers.”

He acknowledges that the high disc loading of the ducted fans means a greater level of power consumption is required for hovering flight. “But we deliberately traded that for an aircraft that is perfectly optimized for cruise flight, and that is where our high range comes from,” he says. He adds that the
configuration also manages to avoid the higher noise usually associated with smaller ducted fans. Without divulging details, Wiegand says: “We have come up with a design of an electric jet engine, or ducted fan, that solves the noise problem and maintains the advantage in cruise flight. So we get the benefit of the higher speed and range of a small cross-sectional engine, and we still achieve very competitive low noise levels.”

With a total of more than 1-megawatt battery power available, the aircraft is designed to fly at up to 300 kph for 1 hr. on a single charge using standard lithium-ion units arranged in lightweight packs developed by Lilium. Wiegand contends that the vehicle will be capable of performing 7-8 urban flights before having to recharge the batteries. This is expected to take 4-5 min. for an additional 60-70 km of range and will likely be doable during the de-boarding/boarding process. “If you do long-distance trips, you will need to spend more time charging on the ground. Unfortunately, recharge times of 5 min. are not yet possible with today’s batteries, so you are probably limited to around 20 min. for a charge up to 80-90%,” he adds.

Flight tests have so far included fore-and-aft transitions, left and right turns and a turn on the spot, both in and out of ground effect. Testing will build on the lessons learned from the first campaign with the two-seat version. “That demonstrator proved its worth in things like control from the thrust vectoring and maneuverability,” says Wiegand. It also unearthed unexpected interactions between sensors and actuators as well as provided data on the coupling and dynamics of the control system, he adds.

The new prototype has thousands of sensors and a sophisticated instrumentation system. “With the first one, we could see some of the control authority and margins, but only in a limited way. We could see that the thrust-vectoring system provides robust control authority, but we will see more with this one,” says Wiegand. The flight-test program is set to include more than 100 sorties and involve several prototypes that will be similar, but not identical, to the initial aircraft.

The company plans to manufacture and operate the Lilium Jet as part of an on-demand air taxi service. “We will operate the vehicle in a transportation service, so our business model is that we are selling mobility, not the aircraft,” he emphasizes. The landing pads, nicknamed Lilypads by Lilium staff, will not be provided by the company. “We do not intend to build or run our own infrastructure—we run the service, [this includes] aircraft operations, pilots, and we design the aircraft, run the bookings and so on.”

Lilium is already developing partnerships for the infrastructure. “Our vision is to have a neutral infrastructure standard that allows all kinds of vehicles to land there, but it also means you have a self-growing marketplace where anyone can build an independent landing pad or some gates and coordinate this into our service,” explains Wiegand.

Lilium hopes to certify the aircraft by 2024 and begin commercial services in various cities around the world by 2025, although trial services will start earlier in several locations.

—With Jens Flottau in Frankfurt
Boeing is close to finalizing its proposed changes to the troubled 737 MAX, including a training package that is likely to be the most debated issue as regulators evaluate whether their confidence in the model’s airworthiness has increased enough to lift global operations bans.

The FAA expects to receive Boeing’s final package, including all documentation, detailing the airframer’s changes to the MAX’s Maneuvering Characteristics Augmentation System (MCAS) by the end of May, and perhaps in time for a May 23 meeting in Dallas with other regulators. Beta versions of the software and proposed training have been reviewed and will be shared at the Dallas meeting.

FAA Acting Administrator Dan Elwell says his agency will not decide on the type or depth of training until the final package is reviewed. This leaves open the possibility that MCAS-related mandatory simulator sessions will be included in the base programs, although they could be inserted as part of recurrent training and not as a prerequisite to getting the 370-aircraft operational MAX fleet back into revenue service.

On May 15, the FAA wrapped up a third round of public input on Flight Standardization Board (FSB) draft recommendations that update baseline 737 training to factor in more information about the MCAS. Comments filed by the Air Line Pilots Association (ALPA) and obtained by Aviation Week reveal that the association did not advocate mandatory MCAS-related simulator training for 737 MAX pilots before they fly again. But ALPA told the FAA simulator sessions may be a prudent step to cover emergency procedures linked to MCAS-failure incidents and should be included in recurrent training.

“ALPA believes that operators must ensure that this system is [taught] in some method, and this case should be examined by the FSB,” says a statement released by the board. “ALPA recognizes [that] the current differences [between the 737 Next Generation and the MAX] are limited to Level B, however, it should be examined that another level of training may be appropriate to adequately [instruct pilots on] this system.”

If computer-based Level B training is deemed sufficient, ALPA insists it should be “robust,” including system details and failure scenarios. “Pilots should receive hands-on flight training on the MCAS during their next recurrent training opportunity or qualification course,” ALPA adds.

The pilot union’s other recommendations focus on MCAS-related differences between the 737NG and the MAX. The MCAS was needed for certification purposes to enhance MAX pitch stability with slats and flaps retracted at very light weights and full aft center-of gravity, ensuring the MAX handled like the NG. The system, which automatically moves the horizontal stabilizer, activates when the aircraft’s speed approaches threshold angle of attack (AOA), or stickshaker stall-warning activation, for the aircraft’s configuration and flight profile. It is triggered solely by AOA data.

ALPA wants MAX training to emphasize the significance of an AOA Disagree alert message on the flight deck. Further, it wants pilots to understand the link between AOA Disagree alerts, which will now be standard on primary flight displays for all MAXs, and the MCAS’ role of automatically moving the horizontal stabilizer to compensate for an AOA approaching aerodynamic stall.

Boeing designed the MCAS to operate in the background, and both the company and the original FSB that worked on the model’s 2017 certification determined that special training on the system’s operation was not necessary. The system was not covered in flight manuals and was largely unknown to pilots outside of Boeing until the October 2018 crash of Lion Air Flight 610 (JT610).

Boeing and the 2017 FSB team also determined that pilots would recognize an MCAS-related failure as a stabilizer runaway, which air transport pilots are trained to handle with a memorized procedure. But in each 737-8 accident sequence, the crew did not
MCAS inputs—triggered by erroneous AOA data—as stabilizer runaway. The pilots countered the MCAS with manual electric trim inputs, which reset the MCAS and caused it to activate again based on the continued stream of faulty AOA data. Boeing's software update removes this function so that electric trim does not reset the MCAS, removing the possibility of it firing again based on faulty data.

ALPA, which represents pilots at U.S. MAX operator United Airlines and Canada's WestJet, also says pilots should practice as many MCAS-failure-related emergency scenarios as necessary to demonstrate competency. Boeing's first detailed explanation of the MCAS, in the aftermath of the JT610 accident, listed nine related "indications and effects" that could result from an AOA Disagree alert and possible MCAS activation.

In a statement to Aviation Week, ALPA emphasizes that its views could change depending on what Boeing's final package of MCAS updates and training modules includes.

“ALPA has not yet determined whether or not simulator training will be necessary to return the 737 MAX to service and will continue to review any and all additional information as it becomes available,” the association says. "Until Boeing formally submits its plan to the FAA for consideration and approval, it is impossible to fully evaluate what actions will need to be taken to ensure the aircraft’s airworthiness.”

Regardless of the final FSB standards recommendations, some regulators and operators are expected to incorporate MCAS-related simulator sessions into their training. Air Canada says it is already using its MAX simulator—the only one in airline hands in North America—to put its 420 MAX pilots through MCAS-related scenarios. Regulators in Europe and China are among those expected to conduct independent reviews of MCAS upgrades.

After Boeing hands its package to the FAA, the last major step is certification flight tests of the MCAS 12.11 software. Boeing and the safety agency are working to complete as much of the work as possible before the May 23 meeting, at which the FAA will present its work on evaluating the MCAS updates and respond to inquiries.

The FAA leaders see the meeting as a key step toward restoring global aviation safety-related collaboration that broke down in the wake of uncoordinated decisions to ground the aircraft. Called by the FAA and first reported by Aviation Week, the meeting is slated to include regulators from many of the 57 countries that banned MAX operations following the March 10 Ethiopian Airlines Flight 302 (ET302) accident. The FAA’s aim: To present details behind its analysis of proposed changes Boeing is making to the MAX’s flight-control computer software and training and to answer questions.

“The goal is to offer all of these countries who have grounded or prohibited [737 MAX operations] the benefit of all the information and all the thinking,” Elwell says. “My hope is that they have the confidence in our work and our analysis to make their ungrounding decisions—if that is where the discussions [goes]—as close to our decision as possible.”

While the FAA is aiming for consensus, it is not seeking affirmation. The decision on letting the MAX fly again will be based on the FAA’s review and input from a technical advisory board, which includes representatives from the U.S. Air Force and the U.S. Transportation Department’s Volpe National Transportation Systems Center.

“The 737 MAX will return to service for U.S. carriers and in U.S. airspace only when the FAA’s analysis of the facts and technical data indicate that it is safe to do so,” Elwell says.

Global regulators, sensing links between ET302 and JT610, began banning MAX operations within a day after the Ethiopian aircraft went down on March 10. Canada and the FAA were the last to issue operations bans, on March 13. Elwell, addressing the House aviation subcommittee on May 15, argued that the two North American agencies were the first to base their decisions on actionable information.

“We were the first [countries] to ground because of data that linked the two accidents,” Elwell said. He cited refined satellite data that connected both accident-flight profiles by showing similar flightpaths and altitude changes that investigators later confirmed resulted from the pilots and the MCAS system providing opposite pitch-trim commands, causing the aircraft to cyclically gain and lose altitude. In each case, the crews could not keep the aircraft’s nose up, and the flights ended with uncontrollable dives. The accidents killed all 346 people onboard the two aircraft.

“It’s important that you establish a link, because you then have what you need to mitigate [risks] and to remove the prohibition order,” Elwell said.

The FAA and other civil aviation
agencies “are collaborative 99% of the time,” he continued. “When the Ethiopian accident happened, it was not a collaborative process . . . despite our best efforts and attempts to have conversations. Countries act, and they act for various reasons.”

Elwell says that while the final changes still must be validated, the FAA is confident in Boeing’s approach.

“We do know that the basic parameters of [the changes], once put on airplanes, mean the [JT610 and ET302] scenarios . . . wouldn’t happen the way they happened,” he says.

Giving pilots more information also should help. The MCAS was not covered in flight manuals—a fact that infuriated many pilots once the system’s link to the JT610 accident emerged. Elwell acknowledges being uneasy about the lack of MCAS information Boeing provided to pilots, who are the last line of defense if the single-source system failed. “As a pilot, when I first heard about this, I thought that there should have been more text in the manual about MCAS,” he says.

While pilots should have had more information on the MCAS, Elwell contends that both the JT610 and ET302 crews missed critical signs that pointed to their central problems: The system was making uncommanded nose-down stabilizer inputs, indicating runaway pitch trim.

“When we looked at [JT610] data and realized that the flight-data recorder showed the runaway pitch trim procedure was not done . . . we knew that this needs to be emphasized,” Elwell says. The result: a November 2018 mandatory flight manual addition that explained the MCAS and highlighted the runaway stabilizer procedure.

“We also added . . . that before you run that procedure, before you physically turn off those stabilizer trim motors . . . you trim the pressure off the yoke . . . so it is in a neutral state,” he adds. “That became critically important with the Ethiopian accident.”

The ET302 crew depowered the stabilizer trim motors but did not counter the MCAS inputs with electric trim inputs beforehand. They turned the motors back on, which the stabilizer runaway procedure says should not be done. This reactivated the MCAS and led to an uncontrollable dive.

Even with the MCAS information at their fingertips following the JT610 accident, the ET302 pilots were not able to manage the failure scenario. This, argues NTSB Chairman Robert Sumwalt, says more about the industry than any particular operator.

“If an aircraft manufacturer is going to sell airplanes all across the globe, it is important that pilots who are operating those airplanes in those parts of the globe know how to operate them,” Sumwalt emphasizes. “The airplane has to be trained to the lowest common denominator.”

Two Megadeals Transform Canada’s Air Transport Market

> ONEX CAPITAL’S BID FOR WESTJET AWAITS APPROVAL

> AIR CANADA MOVES TO ACQUIRE LEISURE CARRIER AIR TRANSAT

Sean Broderick and Michael Bruno Washington and Jens Flottau Frankfurt

Almost exactly 20 years ago, private equity investor Onex had its first go at controlling a Canadian airline: Gerry Schwartz’s firm was trying to merge Air Canada with Canadian Airlines. “It’d take it terribly personally” if the deal failed, he said.

And fail it did. But now Onex is close to gaining control of a large Canadian airline, WestJet, after the carrier’s board recommended accepting a takeover offer. Only days later, Air Canada announced plans to take over Transat, the parent company of leisure carrier Air Transat.

“The acquisition presents a unique opportunity to compete with the very best in the world when it comes to leisure travel,” says Air Canada CEO Calin Rovinescu. “It will also allow us to further grow our hub at Montreal-Trudeau Airport, where we have added 35 new routes since 2012.” Air Canada is not only buying the airline but also Transat’s other branches in the tourism sector. It had been rumored that Onex and WestJet also had been looking at acquiring Transat, which would have created a more formidable competitor for Air Canada.

The leisure airline, like Air Canada, is based at Montreal-Trudeau International Airport. According to the Aviation Week Network Fleet Discovery database, Air Transat operates 39 aircraft, 34 of which are leased. This includes 16 Airbus A330s used on long-haul transatlantic routes. The airline has 12 Airbus A321neos on order. Air Canada is in the process of phasing out its A320-family fleet, to replace it with Boeing 737 MAXs.

“If successful, the combination would allow Air Canada to continue to strengthen their already dominant position in the domestic, Europe and Americas markets,” Cowen Equity Research wrote in a note to clients. “Transat will also allow them to strengthen their leisure brand . . . likely complementing Rouge.” The analysts added: “Our only concern about the transaction is regulatory approval, as Air Canada is already the largest airline in all the markets in which Transat is present. That said, as two Quebec-based companies, we believe the transaction can be approved.”

Onex, now the other major player in Canada’s air transport industry, is no stranger to aviation. Raytheon sold what became Hawker Beechcraft
to a group led by Onex and Goldman Sachs in 2006. Onex also led the carve-out of aerostructures provider Spirit AeroSystems from Boeing in 2005 and divested its stake in Spirit in 2014 only after the latter was on firmer footing.

Onex’s purchase of WestJet is the biggest private equity deal ever in the airline industry and the 16th biggest overall airline acquisition, according to Refinitiv data. It comes amid open speculation on Wall Street that famed investor Warren Buffett could buy an airline, namely Southwest Airlines. There has not been any announcement, but that it is even talked about marks a dramatic turnaround for the once-shunned airline industry.

Ian Cookson, managing director at Capstone Headwaters, a middle-market investment-banking company that works with private equity investors, does not think airlines are the next hot property for private equity buyers. But they are not to be ignored, either.

Onex Capital will purchase WestJet in an all-cash deal valued at C$3.5 billion ($2.6 billion), the companies announced May 13. Including WestJet’s debt, the total value is C$5.1 billion. The deal, which requires Canadian regulatory approval, is expected to close in late 2019 or early 2020.

Analysts at Paradigm Capital think the deal is a bet by Onex that near-term volatility at WestJet will give way to significant, profitable growth. “Onex appears to be taking a long-term view on WestJet,” Paradigm said. “We expect the next 2-3 years to be characterized by ongoing growth as the company embarks on a material expansion of the business,” including adding to its Swoop ultra-low-cost carrier subsidiary and growing its long-haul fleet with Boeing 787s, the first of which arrived earlier this year. “We expect choppy WestJet results over the next 12-24 months,” they said.

Onex approached WestJet in March. The airline formed a special committee to review the offer and consult with its board. The committee approved, and the board agreed. The airline expects to put the deal in front of shareholders during a special meeting in July.

Launched in 1996 as a low-cost carrier, WestJet operates 166 aircraft, including 47 flown by its WestJet Encore regional subsidiary. It operates Swoop, which has six aircraft. The carrier is also in the process of building up its long-haul network across the Atlantic, using three Boeing 787-9s and four 767s. It normally also uses the currently grounded 737 MAX on some long-haul missions. The airline has seven more 787-9s on firm order that are to arrive by 2022, Aviation Week Network data shows.

The airline posted a C$45.6 million profit in the first quarter of 2019, up 30% year-over-year. Revenue totaled $1.26 billion, up 6% year-over-year. But for the full year 2018, WestJet reported a C$91 million net profit, down 67% from C$279 million in 2017. The airline’s full-year revenue came to C$3.5 billion, up 5% over 2017. WestJet had a 3.3% operating margin for 2018, down from a 9.6% margin in 2017.
Clouds Loom on the Cargo Horizon

GLOBAL CARGO DEMAND EDGED UP 0.1% IN MARCH

ESCALATING TRADE TENSIONS WILL HIT CARGO OPERATORS HARD

Helen Massy-Beresford

At the start of the year, European cargo operators were optimistic after a strong 2018, bolstered by a robust demand for transporting fresh fruit, fish and flowers, electronics and fashion items as well as pharmaceuticals and more, by air.

There were some clouds on the horizon, of course—Brexit, trade tensions and high fuel prices—but the mood was optimistic.

Almost halfway through 2019, there has been a marked shift, with cargo operators now expressing much more pessimism about their respective business outlooks. That caution is backed up by the latest figures from the International Air Transport Association (IATA), which said May 7 that global demand measured in freight-ton kilometers (FTK) increased 0.1% year-over-year in March 2019.

“While this is a significant improvement on the 4.9% contraction in February, in seasonally adjusted terms, demand is still down 1.5% over the past year,” IATA said. And freight capacity, measured in available freight-ton kilometers (AFTK), rose by 3.1% year-over-year in March 2019, meaning that capacity growth has now outstripped demand growth for 11 of the last 12 months, the association said.

Airlines in the Asia-Pacific region saw a 3.4% reduction in demand in March, hit by growing trade tensions and a weakening of the Chinese economy, even though the decline was less marked than the 12% drop in the previous month. In Europe, airlines fared slightly better; with a 3.6% increase in demand, which IATA dubbed a positive outcome, given weaker manufacturing conditions for German exporters and the ongoing uncertainty over Brexit.

“The headwinds from weakening global trade, growing trade tensions and shrinking orderbooks have not gone away,” said Alexandre de Juniac, IATA’s Director General and CEO.

First-quarter results from major European operators also show that the good times for the cargo industry may be over, for now at least.

Air France-KLM posted a 2% decline in cargo unit revenues (or 4% at constant currency) when it released its first-quarter results May 3, saying it had seen a slowdown of volumes across the air freight market. This, it said, was “due to economic slowdown, political uncertainties and trade disputes” that put pressure on freight rates.

It said it had undertaken several network rationalization measures to counterbalance the negative trend. “A slight capacity increase has been offset by this unit revenue decrease, resulting in a decline of revenues by 1.3% at constant currency,” the company said.

Lufthansa Cargo reported a 67% decline in first-quarter adjusted earnings before interest and tax to €24 million ($27 million) from €72 million in the same period a year earlier, a fall it said was attributable to downward air freight market trends, especially on routes between Europe and Asia.

Relleasing its own first-quarter results on April 25, logistics giant Kuehne and Nagel also pointed to a global slowdown. CEO Detlef Trefzger said the company increased turnover and profits. “However, we find ourselves in an environment in which global economic growth is noticeably slowing,” he said.

After significant increases in previous years, its air freight volumes dropped 3.1%, to 409,000 metric tons, in the first quarter as the market declined.

Emirates said May 9 its full-year profits fell 69% to $71 million United Arab Emirates dirham ($297 million), hurt by high fuel prices as well as tough competition and unfavorable exchange rates.

“The uptick in global air freight demand from the previous year appears to have gone into reverse gear,” said CEO Sheikh Ahmed bin Saeed Al Maktoum, describing a “tough” year in which “our performance was not as strong as we would have liked,” he noted.

However, its own cargo performance held up against the worsening macro-economic situation: Emirates SkyCargo reported a 5% revenue increase year-over-year, with a 1% increase in tonnage and freight yields measured in FTK up 3%.

Most recently, IAG Cargo also reported that supply continues to exceed market demand. As its parent International Airlines Group reported a first-quarter operating profit of €135 million, down from €340 million a year ago, due mainly to higher fuel costs, weaker unit revenues and unfavorable foreign exchange trends, CEO Willie Walsh said widebody growth is continuing in line with passenger long-haul markets but that this leads to “empty space in the cargo holds.” Walsh expects that impact to continue through the rest of the year and sees no correlation between passenger and cargo demand.

While the mood in the air cargo sector has been somewhat subdued for the past few months, the sudden escalation of long-running trade tensions between the U.S. and China after President Donald Trump’s move to raise tariffs on billions of dollars’ worth of Chinese goods is really bad news for air cargo operators.

“Trade tensions between the U.S. and China are already jeopardizing global growth, but the current escalation could have far more serious consequences, not only for the two main protagonists but also for the rest of the world,” wrote Oxford Economics researchers in a May 10 note.

Although some countries might benefit from temporary trade diversions, the imposition of tariffs on all U.S.-China trade, equivalent to 16% of global trade flows, would reduce global GDP by 0.5% in 2020, they predict.

The Trump administration’s tariff hike would reduce U.S. GDP by about 0.3% or $22 billion and China’s by 0.8%, they estimate, adding: “No one wins trade wars, not even the bystanders.”
Will Fuel Prices Be an Airline Profit Spoiler in 2019?

EXECUTIVES RANK FUEL PRICES LOW ON LIST OF CONCERNS

OIL PRICES COULD CREATE SHORT-TERM PRESSURE, LONG-TERM OPPORTUNITY

Michael Bruno  Washington

Last year, global airline profits ended up being lower than initially expected due to higher-than-anticipated jet fuel costs. Will 2019 be a repeat? Probably not, say several financial analysts who track this market.

“While a headwind in 2018, it has recently stepped back from highs, and we do not currently see higher fuel prices as a material risk in 2019,” says Ken Herbert, an aerospace and defense analyst for Canaccord Genuity.

In late April, Herbert and his team released the results of their latest survey of commercial aerospace, defense and maintenance, repair and overhaul (MRO) industry managers. A decreasing sensitivity to fuel prices was among the findings. When asked about potential 2019 headwinds, MRO executives ranked the rising cost of fuel as the second-to-last factor out of 15 trends driving business conditions.

In early May, jet fuel spot prices hovered at $2/gal., a decrease of about 4% year over year, say Morgan Stanley aerospace analysts.

Still, Brent Crude is up almost a third for the year, according to Vertical Research Partners. Oil prices continue to recover and gained another 6% in April; they are now up nearly 35% for the year after falling around 20% last year. Prices were at about 45% above the 52-week low and nearly 15% off its 52-week high at the start of May.

Although worth watching, it does not necessarily mean longer-term problems. “Airline profits remain good on a global basis, but higher oil prices are creating short-term pressure,” say Sanford C. Bernstein analysts Doug Harned and Christian Laughlin. “We expect fuel prices to moderate later in 2019 with increasing pipeline access to Permian shale oil, so . . . airline profits should remain well-supported.” Morgan Stanley’s airline economic model includes a baseline of $1.95-2.15 for 2019-20.

To be sure, the news cycle often dictates the mood. On May 6, the Trump administration announced it was sending U.S. Air Force bombers and a Navy carrier strike group to the Persian Gulf to ward off alleged Iranian actions in this key oil-producing region. At the same time, President Donald Trump warned of new tariffs against China, fuel are largely passed through.”

Of course, every airline is different. In a report last November, Bernstein analysts noted that the greatest fuel price risk is at low-cost carriers (LCC), followed by long-haul specialists. “The LCCs tend to have very large orderbooks, which could put backlogs for Airbus and Boeing at risk if fuel prices went higher; as they did in August-September 2018 in response to Iran sanction announcements,” they write.

But so far, fallout has been muted. “There are a handful of troubled airlines (e.g. Norwegian), but [there always are] even in the best of times,” the analysts noted in an April 15 follow-up. “The overall profit picture is good in most regions right now. When airlines are profitable, they do not defer or cancel orders. This is good for Airbus and Boeing, with eight years of production in backlog.”

In turn, that means a solid business outlook for the next 3-4 years for manufacturers, as they race to convert existing orders to deliveries. Unknown, however, is the effect of oil-related prices on future orders of large commercial aircraft.

Looking back to 1990, airlines placed large orders while fuel prices were high, and orders have slowed recently as fuel prices have dropped overall, according to Lori Ranson, a senior analyst at Aviation Week’s CAPA – Centre for Aviation. In a February webinar hosted by ICF International, Ranson noted spikes in aircraft orders, with fuel prices rising in 2005-07 and 2011-14. “Most of the new-generation aircraft were introduced during pretty high periods of rising fuel costs,” she said.
The factory, a partnership of OneWeb and Airbus, draws heavily on experience gleaned from manufacturing the first 10 satellites at Airbus’ Toulouse facility. Six of those spacecraft were launched by Arianespace on a Russian Soyuz rocket from French Guiana on Feb. 27. The satellites began arriving at their operational, 756-mi.-high (1,200-km) orbits in late April. Following checkouts and demonstrations, the satellites will become the first members of a planned 650-satellite constellation providing global, high-speed broadband services. OneWeb has U.S. Federal Communications Commission approval to operate a network as large as 1,980 satellites.

The company expects its first revenue to come from maritime and aeronautical applications, followed by government users. Eventually, OneWeb intends to sell to internet service providers worldwide to distribute high-speed broadband to homes and businesses, CEO Adrian Steckel said during the Satellite 2019 conference in Washington in early May.

The satellite bus, however, has applications far beyond OneWeb, including the U.S. military. DARPA in January awarded OneWeb partner Airbus a $2.9 million contract to develop a satellite bus under its Blackjack program, which is intended to demonstrate potential military use of lower-cost, low-Earth-orbiting satellite constellations and mesh networks.

Aviation Week got an exclusive sneak peek at OneWeb Satellites’ Florida factory, located at NASA’s Kennedy Space Center industrial park on Merritt Island. The factory, which is expected to open in late May, builds on Airbus’ experience building airplanes and satellites but parlays those pro-
duction techniques into new, automated systems intended to manufacture two highly reliable satellites per day.

“The culture for doing a geostationary satellite is totally different from what we are doing here,” says production manager Robert Moore. “The mentality here is that we have to work under very tight control and repeatability, which means we always have to build the satellites exactly the same way. When we do that, we can build them a lot faster, as opposed to working on one giant satellite that may take a couple of years.”

The factory relies on software and robotics, with interactive workstations replacing all paper. Inventory starts at one end of the floor, moves through assembly stations, test chambers and then out to a storage area for shipping. “It’s engineered so materials [are positioned] and activities happen in an efficient manner,” Moore says.

Materials come from a roll-up door at one end of the factory and move to where operators are located for inspection prior to being placed on shelves. At the end of a shift, workers will stock kit carts with all the parts needed to make a satellite the next day.

“Operators leave at 3:30 p.m., and all of our kit carts will come out to the different areas so that when a worker arrives the next morning they don’t have to get parts. They don’t do anything but build satellites,” Moore says.

The factory includes an area called “the hospital” to diagnose any hardware issues. “One thing we don’t want to do is stop production. If we ever have a problem in one of our lines, we actually would bring the satellite assembly from there to the hospital so they could fix the problem and bring it back out,” Moore says.

The original idea was to develop an assembly line similar to how circuits and routers are made, but OneWeb founder Greg Wyler tells Aviation Week that higher reliability standards drove the company toward alternative systems capable of consistently producing satellites with the same quality—or better—than traditional geostationary spacecraft that typically take years to build.

OneWeb’s 330-lb. satellites, which cost about $1 million apiece, can be assembled in one 8-hr. shift. “This is a telecom-class satellite, with four reaction wheels, redundancy on the onboard processing system and full redundancy on all the critical components,” says Wyler. “This isn’t a cubesat that we throw up there and maybe it works, maybe it dies; it doesn’t matter. That type of integrity is actually cheaper in the long run.”

The satellites are designed for 10-12-year operational lifetimes.

Satellite assembly is all done on pallets, both to protect fragile equipment and maintain control. Golf-cart-size, self-driving robots move along red lines painted on the factory floor; transporting materials from station to station. Production begins with the propulsion system, which is handled at two workstations, one for assembly and one for testing. Actual touch work is done with custom-built, computerized smart tools. We want the computer, not the operator, to configure the tool, Moore says.

The smart tool checks that the correct drill bit, for example, is attached and that the operator is precisely following assembly steps. Bolts must be torqued in a particular order and a set level of force, and if an operator does not follow the procedure, the tool will not work. “If I keep the operator latched down in terms of what they are able to do, then I always am sure that I have the proper process going,” Moore says.

Optical inspections throughout the process ensure that components have been assembled correctly, with high-resolution images compared to stored scans for reference. “If they don’t match exactly, down to the color of the depth, the computer will stop, bring up the picture it just scanned, and say, ‘You’ve got a problem here,’” Moore explains.

Every image of every satellite will be stored to validate component locations. “If you ever have an anomaly or some issue, you can go back and see what it looked like from every angle,” notes Wyler.

Elsewhere in the factory are stations to assemble and test reaction wheels, solar array motors, onboard computers, star trackers and the satellite payloads. Every area except for solar array assembly has dual lines for simultaneous production of two satellites.

OneWeb, which expects to employ about 70 workers on the lines, plans to operate on just one shift, but it could keep the factory open longer to build for other customers or if a problem on an assembly line causes the need to make up time.

Once avionics and payload components are put together, the satellite heads to a chamber that subjects the hardware to temperatures ranging from -4F to 104F (-20C to 60C) for three days. During the cycles, which last 1.5-2 hr., the satellite transmits and receives signals via its antennas to test the electronics. “It gives us a good indication if we’re going to have a problem,” Moore says.

From there, the satellite heads to final assembly to receive a propulsion module and a lithium battery and then back to a chamber for a 7-day thermal test. Every 50th satellite or so will face an additional three months of lot-acceptance testing in a third chamber that cycles between extreme heat and cold.

The final stage of assembly entails attaching a pair of solar array panels. The deployment mechanism is tested, and then the entire spacecraft is put into a third chamber for a last round of checks.

The factory includes an airlock beyond which customers can pack, store and transport their satellites. OneWeb, which has raised $8.4 billion in funding, expects to start flying batches of 35 satellites on a monthly basis by year-end. OneWeb’s 21-flight, $1.12 billion launch contract with ArianeSpace has most flights taking place from Russia’s Baikonur and Vostokn cosmodromes.
Jeff Bezos Shoots for the Moon

For the past three years, Jeff Bezos’ space company, Blue Origin, has been quietly developing a high-performance, liquid-oxygen- and liquid-hydrogen-fueled engine to power a human-class lunar lander, with the first test-firing expected this summer.

The BE-7 engine, which has 10,000 lb. of thrust and 453 sec. of specific impulse, was among new details of the company’s Blue Moon lunar lander presented by Bezos May 9 during a private event at the Walter E. Washington Convention Center.

Initially, the lander will be capable of delivering 7,716 lb. (3,500 kg) to the lunar surface, or roughly four Mars Curiosity-class rovers. With a stretch tank to carry more fuel, the Blue Moon's cargo load nearly doubles to 14,330 lb., large enough to carry an ascent vehicle for NASA astronauts to lift off from the lunar surface for a return trip to Earth.

When Bezos unveiled Blue Moon in 2017, the project was ahead of its time. NASA was not planning to land astronauts on the Moon until 2028 and had higher-priority human space exploration projects such as finishing the Space Launch System rocket and starting work on a lunar-orbiting Gateway, a small, multipurpose outpost to assemble and command crewed and robotic sorties to the lunar surface, among other tasks.

That changed in March, when Vice President Mike Pence, who chairs the Trump administration’s National Space Council, told NASA to expedite the lunar landing by four years. On May 13, President Donald Trump said he was asking Congress to add another $1.6 billion to his previously requested $21 billion for NASA for fiscal year 2020, which begins Oct. 1. About $1 billion of the plus-up would be used to begin funding commercial partnerships to develop astronaut lunar landing systems and other initiatives to support a 2024 astronaut landing on the Moon’s south pole. Accelerated program costs beyond 2020 have not been disclosed.

NASA still plans to build the cislunar Gateway and operate it in a near rectilinear halo orbit, which helps conserve propellant for station-keeping, in permanent sunlight for solar power production and always in line of sight for communications with Earth ground stations.

But landing astronauts on the Moon in 2024 will force NASA to begin with a rudimentary Gateway, composed of just a power and propulsion element and a small docking section for berthing the astronauts’ Orion capsule and assembling landing-system components. The node also would serve as a habitat for visiting astronauts. Other modules, including those owned and operated by international partners, would be added to the Gateway later.

During his presentation, Bezos did not mention the Gateway as a stopping point for Blue Moon, though he did praise the Trump administration’s plan to speed up the Moon landing. “I love this,” Bezos says. “It’s the right thing to do. . . . We can help meet that timeline, but only because we started three years ago.”

NASA on April 26 modified a presolicitation notice that expands on its previously planned, three-part landing system architecture consisting of a transfer stage to position vehicles from the Gateway to low lunar orbit, a descent module to touch down on the Moon’s surface and an ascent module to fly crew from the lunar surface to the orbiting Gateway and their Orion capsule for a return to Earth. NASA now is open to fully integrated and alternative landing system plans.

Blue Origin’s current focus is on the descent module, which is designed to fit inside the 23-ft.-dia. payload fairing that will fly on the company’s reusable orbital launch vehicle, New Glenn. First launch is expected in 2021.

Blue Moon features:
- A top deck to anchor payloads
- A customizable, U.S. Navy-inspired davit system to lower cargo to the lunar surface
- Star trackers for autonomous navigation in space
- Optical and X-band communications systems
- Side-mounted payload bays to deploy small satellites and experiments prior to lunar landing
- Flash lidar sensors for terrain-relative navigation and precision landing within 75 ft. of a target
- Wide-splay landing legs that can accommodate inclines up to 15 deg.

The company chose liquid hydrogen to fuel the BE-7 descent engine for performance and to prepare for the future when fuel could be made from water on the Moon. The lander also makes use of the liquid-hydrogen boil-off to first cool liquid-oxygen tanks and then to power hydrogen fuel cells.

“We want to be able to survive the lunar night, which you cannot do with solar cells. The lunar night is two weeks long. It gets very cold,” Bezos says, adding that the hydrogen fuel cells are designed to generate 2.5 kW of power.

To accommodate a wide range of masses—the lander weighs 33,000 lb. fully fueled but 7,000 lb. just before touchdown when the fuel tank is nearly empty—the BE-7 is deeply throttleable to provide the right amount of force as the vehicle sheds weight. The primary descent burn will last 6 min., with the lander shifting to a vertical position 0.62 mi. above the surface, Bezos says.

While Blue Origin has NASA squarely in its sights for Blue Moon landing services, the company also has recruited a science advisory board and signed its first customer contracts. “It is this generation’s job to build a road to space so future generations can unleash their creativity,” Bezos says. “When the infrastructure is in place—just as [the internet] was for me in 1994 to start Amazon—for the future space entrepreneurs, you will see amazing things happen.”

Irene Klotz Washington

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HYDROGEN-BURNING BE-7 IN DEVELOPMENT FOR LANDER

UPGRADED VEHICLE CAN SOFT-LAND 14,330 LB. ON MOON

Jeff Bezos Shoots for the Moon

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NASA’s Neocam To Watch for Asteroid Strikes

POLAR-ORBITING NEOWISE TELESCOPE TO END MISSION LATER THIS YEAR

NASA SEeks BUDGET WEDGE FOR FURTHER NEOCAM DEVELOPMENT

Mark Carreau Houston

A s NASA looks to step up its detection of potentially dangerous near-Earth objects (NEO), it is working on a dedicated deep-space observatory first proposed more than a dozen years ago.

Neocam, a sensor equipped with infrared optics that include a 50-cm (20-in.) aperture and 4-4.5-micron and 6-10-micron wavelength channels, would be launched to the Earth/Sun L1 Lagrange point, a gravitationally stable space coordinate about 1 million mi. from Earth in the direction of the Sun. Once there, Neocam would trail the Earth as it orbits the Sun, with a wide field of view of the Solar System to help identify, track and characterize potential impactors large and small.

“From my perspective, there are a couple of critical questions we want [answered] about NEOs: when they might impact on human versus astronomical and geological timescales, and how bad they might be,” Amy Mainzer, Neocam’s principal investigator, said at the International Academy of Astronautics Planetary Defense Conference meeting at the University of Maryland on April 30. “This breaks down to finding the objects and getting good, reliable orbits for them,” she said.

NASA’s Planetary Defense Coordination Office charted its 20,001st NEO discovery on April 26. In 1998, Congress directed NASA to discover 90% of NEOs 1 km (0.6 mi.) and larger, a goal it achieved in 2011 and continues to pursue, with a tally so far of 897. In 2005, lawmakers upped the ante by 2020 to 90% of all NEOs 140 m (460 ft.) and larger, sizable enough to devastate a large city or region. That count stands at 8,576, well under an estimated 25,000 such objects. NASA will not meet the 2020 goal, says Lindley Johnson, NASA planetary defense officer.

Neocam should be capable of achieving the objective within a five-year mission, while detecting 300,000 NEOs smaller than 140 m, says Tommy Gray, a fellow Neocam researcher from the Planetary Science Institute in Tucson, Arizona.

Johnson says a major collision does not appear to be coming, but no one knows. “If we talk about the next 100 years, there is a large probability there could be a significant impact from which people would get killed if we don’t know about it in time,” he says.

The NEOs that have entered the Earth’s atmosphere and exploded range from about 60 ft. (18 m) in width at Chelyabinsk, Russia, on Feb. 15, 2013, which exploded with a force 440,000 tons of TNT, sending a shockwave across 200 mi., injuring more than 1,600 people, to 120 ft. at Tunguska, Russia, on June 30, 1908, which exploded with the force of 185 Hiroshima atomic bombs, leveling several hundred square miles of forest with an acoustic force registered in London, to 6.2 mi. wide at Mexico’s Yucatan Peninsula, which is blamed for a blast 65 million years ago that destroyed 70% of all life on Earth, including the dinosaurs.

Mainzer stressed the challenges of developing the Neocam survey within the cost parameters of a NASA Discovery-class mission, which includes a $400-500 million cost cap.

Infrared (IR) rather than optical sensors will help experts better characterize the size, mass and orbital velocity of asteroids that cross or come very near Earth’s orbital path, based on heat absorbed from the Sun, allowing experts to estimate their kinetic energy potential. At Earth/Sun L1 and with proper sun-shielding and a radiator, the IR optics can be chilled and maintained at 40K (-390F), cold enough to not require a more expensive and time-constrained cryogenic cooling, Mainzer said.

The Neocam strategy had a test run of sorts in 2013, when NASA reactivated the Earth-orbiting Wide-field Infrared Survey Explorer (WISE), an astrophysics mission launched in late 2009 and deactivated in 2011 after completing its primary mission to observe distant galaxies, stars and Solar System objects. The rechristened Neowise is credited with 788 NEO and 196 comet characterizations. However, the aging, polar-orbiting Neowise mission is expected to end this year as the telescope loses its cooling capabilities.

Mainzer, who also is the Neowise principal investigator, noted that Neocam’s only mission will be to detect NEOs and other small Solar System objects that may have once been parent bodies. A late-2020s launch date is envisioned. NASA is seeking a budget wedge to pursue Neocam development beyond the instrument phase under its Discovery planetary science line.

The instrument phase has been under extended development since 2011, according to Mainzer. The Neocam project is awaiting permission to proceed to Discovery’s Phase B Key Decision Point, or the second stage of development, she said.

During a keynote speech to the Planetary Defense Conference on April 29, NASA Administrator Jim Bridenstine pledged to meet with Tom Zurbuchen, NASA associate administrator for science, and Lori Glaze, NASA director for planetary science, to find financial support for Neocam.

NASA’s proposed 2020 budget projects spending $150 million a year on planetary defense through 2022. “We will have a conversation about ultimately how to get that funded and fielded,” Bridenstine said of Neocam and deliberations with Zurbuchen and Glaze. “But know this: We are committed to doing that.”
UNMANNED AVIATION

Regulatory Uncertainty Roils UK Drone-threat Response

GATWICK INCIDENT BOOSTED INTEREST IN COUNTER-UAS

BROAD REQUIREMENTS, UNCLEAR REGS ARE CHALLENGING INDUSTRY

Angus Batey Deenethorpe, England

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n the edge of a former UK Royal Air Force base, next to a ruined 1930s operations building now used as a sheepfold, a defense contractor is demonstrating the future of civil air defense for a documentary TV crew. While a DJI Phantom 3 drone hovers above the runway, a team member in the back of a Ford Transit van explains how Leonardo’s Falcon Shield system detects and identifies small unmanned aircraft—and could be used to cause a targeted aircraft to crash.

The Falcon Shield counter-unmanned aircraft system (CUAS) includes a radio-frequency (RF) detector, electro-optical and infrared cameras, command-and-control software and operator workstation, and an effector capable of jamming links between a rogue drone and its remote pilot. The system is modular and has an open architecture, allowing other elements to be added: Leonardo has worked with Thales-owned UK radar manufacturer Avelliant to integrate its 3D, active, electronically scanned array radar into the Falcon Shield. This enables the detection of drones that are not emitting or receiving RF—for instance, if the aircraft is following a preprogrammed GPS flightpath.

The Royal Air Force (RAF) deployed parts of Falcon Shield to London Gatwick Airport last December in response to incursions into the airport’s airspace by drones flown by persons still unknown. The incident and the RAF’s remedial action caused the airport to cease operations for four days. The same RAF-owned and-operated equipment was deployed to London Heathrow in January, when another rogue UAS forced a much shorter shutdown of that airport.

Leonardo officials say interest in the system, which has been available since 2015, has spiked since the two high-profile airport closures. Yet this demonstration helps highlight some of the problems encountered as government regulatory boards grapple with establishing requirements to protect civilian infrastructure from rogue drone incursions.

Despite more than two months of talks between the company and various government departments, approvals to demonstrate the system’s Guardian effector have not been issued, although the GPS and RF jamming signals it emits affect only a narrow, 20-deg.-wide sector. Also, the permission requested was for a small number of 20-sec. bursts of energy in a relatively remote region, restricted only to the frequencies used by the drone.

The team instead simulates what would have happened had the jammer been on; in the back of the van, they show a short video shot at a military electronic-warfare range—so far, the only site in the UK where the jamming capability has been demonstrated.

Like cyberdefense, counter-UAS technology presents significant legal and regulatory challenges for governments worldwide. To effectively protect elements of critical infrastructure, military-grade solutions will often need to be deployed by civilian agencies or commercial entities in a homeland environment where second- or third-order effects are difficult to predict.

“Civil airports won’t be in the game, necessarily, of jamming drones routinely, unless legislation changes,” says Paul Burt, vice president of sales in Leonardo’s electronics division. “We’ve seen some of that legislation change as a result of Gatwick and Heathrow. But—and this is just my opinion—I don’t see airports sitting on a bunch of jammers 365 days a year. They may wish to embrace that as part of their modus operandi, in extremis. But legislation would have to catch up.”

Gatwick’s travels may have focused attention on CUAS and the need for airports and national authorities to coordinate an effective and timely response. But that incident, and the brief Heathrow closure on Jan. 8, underscore how complicated and multifaceted the rogue drone problem can be.

The aircraft sighted at Gatwick were multirotor designs typical of most consumer drones, while the Heathrow incident involved a larger, fixed-wing platform. Systems such as the Falcon Shield can usually find the location of the remote pilot—an important aspect of any law-enforcement operation in response to a drone incursion on a civilian installation, as an arrest may well be the only way to terminate the attack.

So, as well as being able to identify and track both the smaller, slower-moving rotorcraft, a CUAS for a major airport will also have to be able to perform the same job on larger, faster fixed-wing drones, possibly being flown to the location from considerable distances—and to cue law-enforcement agencies as to where the operator may be. Yet even a system that can do all that might not be sufficient.

“What we do know about the drones [at Gatwick] is they were designed or adapted to evade some forms of drone detection, and that is why police haven’t been able to identify where the operator was,” says Andrew McQuillan, founder and director of Crowded Space Drones, a consultancy that works with police, venue owners and infrastructure providers to help secure airspace over facilities that host large numbers
Leonardo’s Falcon Shield system—with the Guardian effector (left), Skyperion radio-frequency detector manufactured by Metis Aerospace (center) and Nerio EO/IR sensor (right).

of people. “Some aspects of [the inci-
dents] were deliberately designed to
cause disruption. We are not talking
about commercially sold drones, for
the most part,” McQuillan says.

The challenge will only become
more acute as new generations of
drone technology arrive in the con-
sumer market. The advent of LTE-
equipped drones—where the com-
mand-and-control data link is, in
effect, a cellphone call from the op-
erator to the aircraft—will enable pilots
to be miles, perhaps even continents,
away from the air vehicle. Arresting
pilots in that case will be impossible,
and jamming would risk disrupting
cellphone communications in the area
where the drone is flying.

The challenges facing CUAS de-
velopers do not stop there. During a pre-
sentation to the International Security
Expo in London last November—before
the Gatwick and Heathrow incidents—
Peter Clarke, director of CUAS pro-
grams for the UK Defense Ministry, ex-
plained that the British military’s CUAS
requirement set is so broad it challeng-
es existing procurement processes. As
well as protecting fixed installations,
such as military bases and airfields, the
military will require CUAS protection
for a host of different scenarios.

“When I go to industry, most peo-
ple are designing the protected-base
solution,” he said. “However, we also
need to consider mobile convoy pro-
tection—for foot patrols and ships——
where I’m seeing a lot [fewer] industry
solutions.”

These different forces have pushed
the Defense Ministry away from a
conventional process of drafting a re-
quirement, running a competition and
selecting a single provider. Instead,
Clarke said, the military is borrowing
a concept from the CPNI—Center for
the Protection of National Infrastruc-
ture, a division of the UK’s homeland
security service MI5—which intends
to procure CUAS via what it terms
an Equipment Catalog.

“That means we will be constantly
evaluating potential solutions,” Clarke
said. The ministry will perform an
initial screening of ideas submitted,
then evaluate and approve those that
look likely to provide viable parts of an
overarching solution.

“As far as [the Defense Ministry is]
concerned, [once] a piece of equipment
has gone through competition, it is sit-
ing in the catalog waiting to be pur-
chased,” he said. “So next time we have
an urgent operational requirement, we
can just dip into the latest version of
the catalog and buy what is there.”

For civilian entities looking to pro-
tect airports, sports arenas or other
fixed locations, the problem sets may
be more tightly defined—but there is
limited overlap between the CUAS
available in the marketplace, with each
offering varying levels of protection
against slightly different pieces of the
problem. The key question for poten-
tial purchasers is less “Which system
should I buy?” than “What threat do I
wish to protect myself against?”

Industry must work with custom-
ers to ensure the CUAS offered fit the
purpose. In Leonardo’s case, an initial
risk-assessment exercise is consid-
ered as an integral a part of the Falcon
Shield as the sensors or effector.

“We’ve got access to a piece of soft-
ware that allows us to provide an initial
consultancy to a customer,” says Andy
Roberts, Leonardo’s sales and market-
ing manager. “We use our knowledge
of what the systems are capable of, and
3D mapping of where that customer
has that problem for which they need a
solution. [We can then propose an ideal
one] . . . within their budget.”

For smaller CUAS providers, the
answer may be to help customers un-
derstand that an effective system need
not guard against every possible threat.
Aoronia, a German company specializing
in spectrum analyzer products, be-
gan developing its Aartos CUAS three
years ago and in 2018 sold more than
100. Customers include the Belgian po-
lice, which used it to protect the 2018
NATO summit from drones, following
deployment during the Singapore
meeting between U.S. President Don-
ald Trump and North Korean leader
Kim Jong- Un.

Thorsten Chmielus, the company’s
founder and CEO, says the next, fifth,
generation of the system will be the
first on the market to detect and defeat
LTE drones—but the current system
relies on an RF detector as its prima-
ry sensor. While this will not guard
against nonemitting drones, Chmielus
argues that those are now a theoreti-
cal rather than an actual threat—and
that Aartos can protect a site against
the majority of rogue drones.

Most people who fly drones at air-
ports are “just idiots,” he notes. “They
think it’s cool to make a picture in front
of an [Airbus] A380 flying directly over
you: You can post it online and get a
lot of ‘likes.’ So what you have to do is
protect against idiots.”
**Lung-Like Propulsion Drives British Long-Endurance UAV**

> THE PHOENIX FLEW FOR THE FIRST TIME INDOORS IN MARCH

> REVERSIBLE FUEL-CELL TECHNOLOGY COULD SUPPLEMENT BATTERIES AND RECHARGE HYDROGEN

**Tony Osborne** London

A British team has flight-tested an autonomous aircraft powered by variable-buoyancy propulsion that engineers say could deliver a novel lower-cost approach for the missions performed by high-altitude pseudo-satellites (HAPS).

The Phoenix, a joint development of several UK universities and small businesses, is the result of a three-year project to study the potential of a variable-buoyancy propulsion system on an aircraft.

Until now, such a propulsion system has been adopted for use only on autonomous underwater vehicles (AUV), giving them the endurance to survey the oceans.

Essentially a 15-m-long (49-ft.) monoplane with a 10.5-m wingspan, the Phoenix features a large bulbous fuselage filled with 120 m³ of helium to help the aircraft ascend. Also contained inside the fuselage is an inflatable bag with a 6 m³ volume that draws in and compresses air, making the craft heavier than air. As a result, the Phoenix descends, and the wings convert that movement into forward motion. When the compressed air is released through a vent in the rear of the aircraft, it becomes lighter than air and ascends again, with the wings again converting that into forward flight.

Once airborne, the platform is virtually self-sufficient and could theoretically stay aloft for an unlimited period, says Andrew Rae, professor of engineering at the University of the Highlands and Islands, who led the design of the aircraft.

And most crucially, say engineers, it can do so at a much lower cost than other HAPS platforms such as the solar-powered monoplanes developed by Airbus and Prismatic.

Some comparable vehicles are more complex and expensive, says Rae: “A cheap, almost disposable aircraft like this will mean you can do things with it you would not contemplate with a more expensive aircraft.”

The fuselage—constructed from a Vectran-based woven material—retains its rigidity through internal pressure; the wings use carbon-fiber sandwich panels for the ribs, spars and a lightweight skin.

Solar panels on the wings and horizontal stabilizers charge lithium-ion batteries that drive the pumps and compressors, enabling the Phoenix to operate comfortably at altitudes of 3,000 ft. Even at those altitudes, the platform could act as a flying cell phone mast in areas struck by natural disasters. However, the team is firmly focused on the HAPS mission, although Rae says the aircraft would have to be scaled up considerably to give it stability and inertia to counter wind gusts at high altitude.

Hydrogen, a gas given “bad press,” according to Rae, could also be used as an alternative to helium, in part because it allows higher altitudes to be attained and is now considerably cheaper than helium, due to international shortages of that gas. The team has also explored use of a reversible fuel cell developed by the University of Newcastle to complement the batteries and allow the aircraft to recharge the hydrogen gas onboard for future versions.

Funding for development of the Phoenix has been provided by the British government’s Innovate UK agency. Other academic institutions involved in the project include the University of Bristol, which worked on the carbon-fiber wing and tail structures, wing skins and gondola, and the University of Sheffield, which conducted wind-tunnel testing.

The future of the Phoenix and its technologies will very much depend on market interest and “specific missions,” says Rae.
SureFly Touts eVTOL Hope Amid Funding Uncertainty

> CAPITAL IS NEEDED FOR PROTOTYPES
> PARENT COMPANY WORKHORSE IS FACING FINANCING HURDLES

Eric Tegler Washington

A t the Washington Auto Show in April, SureFly founder Steve Burns held forth before a crowd of automotive journalists, pitching his company’s octocopter as more akin to a car than a helicopter. Most of them seemed impressed, though unsure how a two-seat hybrid-electric air vehicle that looks like a typical small UAV might become a flying car for everyone.

Their uncertainty mirrors the capital markets, which have so far given SureFly and its parent company, U.S. truckmaker Workhorse, a vote of no-confidence by abstaining from investing. Workhorse, which is developing electric, potentially autonomous delivery trucks, pickups and drones, has struggled to attract capital and achieve production of its vehicles.

SureFly’s struggle comes amid signs that the hyped-up electric vertical-takeoff-and-landing (eVTOL) market may be facing challenges to raising the funding required to move from building subscale models and proof-of-concept vehicles to prototypes and certification. Another startup, Detroit-based Airspace Experience Technologies, has turned to a crowdfunding campaign in a bid to finance its MOBI-One tilting eVTOL.

The fly-by-wire SureFly air vehicle, which has eight rotors mounted in coaxial pairs on four arms over the cabin, first flew (briefly, to a height of about 20 ft.) in April 2018. Last fall, the company entered type certification with the FAA, the first for an electric helicopter. But in October, Workhorse announced it would be selling SureFly, ostensibly to maximize its market potential.

But Workhorse has continually burned through capital provided by a series of creditors, and reportedly was forced into the sale to satisfy a covenant with financier Ares Capital Management. Workhorse is now facing a May 31 deadline to meet a $4 million minimum liquidity requirement from its latest backer, Marathon Asset Management.

Where does that leave SureFly? Despite Workhorse’s near-bankruptcy, it is not in jeopardy, according to Burns. But Burns, who left his position as Workhorse’s CEO in February, has issued sometimes conflicting statements about Workhorse and SureFly’s prospects.

“I don’t think Workhorse is going to fold,” he asserts. “I think Workhorse is going to be super-successful, and I think SureFly is going to be super-successful.” But the former CEO also concedes that Workhorse needs capital, which it has only raised in small chunks. “That could be death by a thousand cuts, or it could be brilliant; we’ll see,” says Burns.

Workhorse is still providing SureFly with funding “sufficient to increase the state of the art,” he says, following quick-ly with the observation, “If we wanted to build five vehicles and give them to the FAA for all the things they’d like to do, that requires capital.”

FAA type certification will require time, Burns acknowledges. He cites the 13-year span it took Honda to certify its HondaJet, but he expects SureFly to beat the major airframers in a race to certify eVTOL air vehicles. Given that Uber has said it expects to be operational by 2023, that timeline (although probably unrealistic) is short.

In the present regulatory environment, the SureFly would likely operate as a conventional helicopter much like Robinson Helicopter’s two-seat R22, which sells at a price similar to SureFly’s projected $200,000 sticker.

The R22 would not compete with his aircraft, Burns says, because SureFly is radically different—built to be far easier to fly by those with light-sport-pilot (or less) experience, to launch with short spin-up times (electric rotor drives start immediately) and to offer safety (it incorporates an airframe parachute) beyond conventional helicopters.

“We’ve already presold more SureFlies than they sell R22s per year,” Burns says. Robinson tells Aviation Week it sold 33 R22s in 2018. “Presold” refers to the $1,000 deposits SureFly has taken thus far. Burns says these are fully refundable but specifies no set delivery date. “Personally, I think we will sell 1,000 of them the first year we go into production. That’s what we’re telling our suppliers, building for that volume.”

Selling the SureFly octocopter is one thing, selling the company is another. In the eight months it has been for sale, no practical offers are in the works, though Burns says he has spoken with “a few aerospace companies, a few billionaires, a few like-minded people because this came out of an electric truck company.”

In the absence of commercial buyers, government interest could be a lifeline for SureFly. In Washington, Burns said Workhorse had signed a cooperative research agreement with a military organization. The Air Force Research Laboratory (AFRL) has confirmed an agreement with Workhorse but was unaware of SureFly’s possible sale.

The laboratory says the agreement is solely an information-sharing agreement, but if the company’s technology matures, “AFRL could then potentially pursue more ambitious goals in cooperation with SureFly.”

SureFly’s founder would certainly welcome that and intimates that something more might come of the agreement, without specifying what. Burns says Workhorse is not in a race to produce a product before it runs out of money, and that SureFly will survive without a buyer.
The bomber is back.

Thirty years after the Northrop Grumman B-2 became the last all-new bomber design worldwide to achieve a first flight, the 28th Bomb Wing here has started preparing for the arrival of the first B-21 Raider, due within six years.

Only days after the U.S. Air Force announced in late March that the first B-21 operational squadron would be based here, the wing proudly splashed “Raider Country” in bold brown paint across the installation’s largest hangar. Program staff also briefed the wing’s leadership on the B-21 itself, telling them to expect the future bomber to fly as quietly as a Boeing 737. The next step is to decide where to place the new B-21 wing. Options include using the two rows of hangars that once housed B-52s or building new facilities on the other side of the runway.

“We’re doing a lot of planning now for the eventual B-21 bed down here in the mid-2020s, because that is going to change what our base looks like,” says Col. John Edwards, 28th Bomb Wing commander.

The pending arrival of the B-21—and the effect of its equally secretive peers now in development in Russia and China—could change the structure of the world’s three most powerful air forces.

Ellsworth’s preparations mark the beginning of a new era in long-range, strategic aircraft. In the U.S., Russia and China, militaries and industries spent lavishly and labored long over the last two decades to develop and field a new class of stealthy, short-range tactical aircraft. As the initial versions of the Lockheed Martin F-35, Sukhoi Su-57 and Chengdu J-20 development wind down, a change in focus is evident. In all three countries, the new priority among air forces is to usher a new generation of bombers through flight testing and into production as quickly as possible.

Besides the B-21, Russia’s Interfax news agency has reported plans to roll out the Tupolev-designed Promising Aeronautical Complex for Long-Range Aviation (PAK DA) within two years. In China, Avic officials have hinted that the rollout of its new H-20 bomber could happen soon, perhaps even this year. All three countries are also investing heavily to modernize
The bomber is back. Options include using the two rows of where to place the new B-21 wing. Opinion is growing that the Air Force needs to retire its B-2s and B-1Bs early. Although only 18 months old, the Bomber Vector seems almost quaint. The Air Force itself seems conflicted. Only nine months after Global Strike Command issued the plan in January 2018, the service released a contradictory internal study calling for an increase of the bomber force to 14 squadrons, from nine.

A study co-authored by Gunzinger agrees but goes further and calls for more than doubling the size of the bomber fleet to 19 squadrons. A separate, classified, recent review of the Air Force fleet structure by The Mitre Corp. also calls for adding bomber squadrons to the future force, according to Gen. Timothy Ray, head of Global Strike Command.

The Senate Armed Services Committee plans to insert a provision in the National Defense Authorization Act requiring the Air Force to effectively redo the Bomber Vector, according to a source familiar with the discussions.

Revisiting the Bomber Vector also now has the support of Global Strike Command, for which Ray assumed command last year after the road map was published. In testimony before the Senate committee on May 1, Ray said the disputed Bomber Vector was based on a “programmatically driven” analysis. In other words, his command’s long-term bomber road map is based on current budget constraints, not an objective analysis of the operational need.

“The analysis that we’re looking at from inside [the office of the Secretary of Defense] and inside the Air Force will be at the forefront of anything that happens,” Ray said.

“The decision point to look closely at the B-21 production rate is in about the 2024 time frame,” he said. “We’ve got a good program and very good program managers there, so once we get to that point, we all agree we have some options. But in the meantime, we have some sustainment options we’re going to look at to make the bomber road map we have more affordable.”
Meanwhile, the Air Force’s firm lid on even unclassified details of the B-21 program is loosening, albeit slightly. It started last December with confirmation of the completion of the critical design review, a milestone that traditionally means releasing suppliers to begin manufacturing components for the first test aircraft.

This slightly relaxed posture also extends to one of the B-21’s tightly guarded, although unclassified, secrets. Assuming the Air Force’s planned initial operational capability date in the late 2020s is accurate, Northrop is about one-quarter of the way through the $21.4 billion development phase that began in October 2015. The size and timing of the low-rate initial production (LRIP) phase became public only this year, although not via traditional channels. No B-21 procurement spending figures were included in the budget justification documents for the Air Force’s fiscal 2020 spending request, but service officials agreed to confirm the numbers upon request.

The new budget data reveals a $5.9 billion spending plan over the next five years for an unspecified number of aircraft. That amount likely covers the first two annual lots of LRIP, plus long-lead funding in fiscal 2024 for LRIP-3. The procurement phase of the program begins in fiscal 2022 with a planned outlay of $200 million, which likely is for long-lead materials for LRIP-1. The Air Force then plans to spend $2.4 billion in fiscal 2023, the first full lot of production and long-lead for LRIP-2. The long-term budget allocates another $3.3 billion in fiscal 2024.

Since former Defense Secretary Robert Gates capped the average cost of the B-21 at $550 million in fiscal 2010 dollars, the new procurement data allows analysts to estimate the number of aircraft in each of the first two lots of production and build a projected ramp-up...
for deliveries over the next decade.

In a report published in April, the CSBA used the Air Force's new procurement data on the B-21 to make such an assessment. The CSBA analysts, which include former Pentagon budget programmers, assessed that Northrop could deliver as many as 55 operational B-21s over the next decade, starting with the first production aircraft in 2024. Five more B-21s would be delivered in each of the next three years, increasing to 10 in 2028 and 15 each in 2029 and 2030.

So far, Northrop’s performance is reaping praise as the program transitions from design to manufacturing. All defense officials repeat the encouraging, if vague, refrain that the B-21 development work is “on track.” More telling, Rep. Rob Wittman (R-Va.), ranking member of the House subcommittee that oversees the program, told Aviation Week in March that Northrop had resolved a design issue that he publicized last year, in which engine supplier Pratt & Whitney and Northrop had disagreed about the size of the inlet.

As that program got underway, the Air Force also began a structural integrity analysis on the B-1B airframe. One aircraft was used to perform a complete durability test, which revealed a lengthy list of required work to keep the structure airworthy for two more decades. “It’s the main fuselage, the wing roots, the swing-wing gears, elevators,” says Col. John Edwards, commander of the 28th Bomb Wing at Ellsworth AFB. “It’s what we need to do to keep the aircraft in the inventory for 20 years.” The service life extension program (SLEP) for the aircraft will get started by year-end, which is the first quarter of fiscal 2020, he says.

The structural revival for the airframe and engine begins as the Air Force wraps up the most significant systems upgrade for the B-1B fleet since production ceased in 1988.

The first B-1B squadron equipped with the Integrated Battle System (IBS) made its first combat deployment last year, arriving in U.S. Central Command to support the campaign against the remnants of the Islamic State group in Syria.

In a sign of its advancing age, the Air Force fielded the B-1B in the late 1980s with the same avionics and mission computers as the NASA Space Shuttle, which were both designed by Rockwell International (now Boeing).

In 1998, the Air Force’s decision to remove nuclear weapons from the B-1B included a major investment called the Conventional Munitions Upgrade Program. By the program’s end in 2006, Boeing had revamped the avionics to release flexible load-outs with a wide mix of guided weapons. The aircraft’s original six mission computers—operating a 1960s-era software language called Jovial—were replaced with four new processors running on an updated version of the ADA software code.

In essence, the nearly $900 million IBS upgrade completes the B-1B avionics refresh by adding modern, color vertical situation displays, fully integrating Link 16 and installing a new troubleshooting alert system for maintainers. The improved connectivity and cockpit displays allow B-1B crews to be active participants in a strike force package for the first time, trading sensor and targeting data with other aircraft during a mission. It is a capability most fighter pilots in the Air Force fleet have taken for granted in the last two decades, but it has finally come to the service’s largest conventional weapons carrier.

As the B-1B has evolved, the Air Force faces some decisions as to its direction. Since 2015, the B-1B fleet has been assigned to Global Strike Command, which otherwise manages only nuclear forces. The Air Force has complained about the offensive capacity shortfall caused by the slow replacement of the fighter fleet, so some experts, led by the Air Force Association’s Mitchell Institute, are calling on the service to use its B-1B’s more like long-range, tactical munitions “trucks” than conventional bombers.

“The B-1 is effectively a big F-15E for a good portion of the roles,” says Doug Birkey, executive director of the Mitchell Institute. “It makes no sense to us [to] retire B-1s when, with some minor SLEP work, you can keep [them around for] a few more years.”
U.S. Army Shakes Up Pilot Training Programs

LAKOTA FORCE TRIM DEGRADED TO FLY MORE ‘OLD-SCHOOL’

FORT RUCKER GAINS LAKOTA HOT-REFUEL CAPABILITY

Lee Hudson Nashville, Tennessee

The U.S. Army is downgrading technology in its new Eurocopter UH-72 Lakota fleet so student pilots can master basic flying skills instead of having the modern helicopter automatically perform those tasks. But concurrent with the service’s old-school methods of inculcating these skills, it is revolutionizing its training with virtual reality and the use of classified scenarios, which helps Fort Rucker, Alabama, prepare aviators for multidomain fights.

The new training methodology is an outgrowth of an internal review known as the aviation warfighting initiative (AWI), which focused on how to produce higher-quality aviators without requesting additional funds from Congress, Col. Chad Chasteen, 110th aviation brigade commander, tells Aviation Week.

AWI assessed the first half of flight school and expanded on specific types of aircraft such as Boeing Apaches and Chinooks and Sikorsky Black Hawks.

In April, Chasteen’s team altered the basic Army aviator course at Fort Rucker, which is designed for brand-new pilots.

“We want to increase proficiency for students in basic tasks and tactical fundamentals,” Chasteen says. “We’re not focused so much on qualifying them for the aircraft but on teaching them the skill sets they need to fight and win in a multidomain environment.”

The Army decided to degrade the force trim that keeps the flight controls neutral on the modern UH-72 Lakota to make it a more unstable helicopter. Now students must use the pedal input, pull up the collective and add the cyclic to maintain a stable aircraft. “What we’ve done is made this modern aircraft fly a little more old-school,” Chasteen says.

The new training construct adds an extra week to flight school—nine instead of eight—to provide students the opportunity to perform more repetitions of basic maneuvers and emergency procedures, he says.

“We’re not allowing the computer to fly the aircraft, the student is,” Chasteen says. “Their hands are flying the controls, and they are learning to maneuver the aircraft.”

Students navigate without GPS, using a map, clock and compass because in combat—if the pilot is flying in a GPS-denied environment—the aviator does not have the option of relying on satellite-enabled technology.

Another new capability the Army added at Fort Rucker is the ability to hot-refuel the Lakota, which means putting gas into an aircraft while it is running. This task also creates a more realistic training environment for students and provides additional flight time instead of having to wait on a cold refuel.

New pilots are taught to plan a mission tactically, how to hold a briefing, and to think about how things could go wrong. Each student will conduct an attack, reconnaissance and assault mission before moving to their combat aircraft. These are new requirements for aviator training, Chasteen says.

In addition, Fort Rucker will receive 30 virtual-reality systems over the next year to see if the cutting-edge technology can produce pilots who are more capable of handling any situation. Within one year of using the new simulators, Chasteen anticipates the service will have collected enough data to determine the correct structure for flight school to produce proficient pilots.

“We’re going to get to the point with virtual reality that we will be able to make a virtual traffic pattern,” he says. “[Trainees] can follow that, and if
[they] are on the pattern, they’ve met the Army standard, and it is going to be graded [virtually]."

Cognitive tools and biometric feedback could also be incorporated during flight school. For example, a technology that measures a person's iris can be used to determine where the subject is looking.

“If a student is not understanding how to do a maneuver, you can pull it up and see what they’re looking at,” Chasteen says. And then their erring makes sense because you can see where the trainee has gone wrong, he notes, adding: “It helps inform the instructor pilots.”

The AWI discovered that the course for the CH-47 did not include terrain flight orientation, which means students were not flying below 300 ft. (91 m). “Think of the environment now—we have a near-peer threat in Eastern Europe, and the students are coming out and they’ve never flown among trees,” he says.

The CH-47 course was overhauled, academic days were removed, and not a single flight hour was added, but terrain flight orientation is now part of the syllabus. Students are qualifying to fly under 200 ft. in both day and night conditions. This is followed by a culminating exercise where students plan as a group to accomplish a mission with an imaginary ground force against an adaptive enemy.

The AWI identified modifications to the instructor course and found it focused too much on technical aspects such as wire diagrams and aircraft systems. The emphasis has shifted to how to train others on Army tactics, doctrine and employing the aircraft.

The other revolutionary move added to the Army aviation pilot instructor curriculum is tactical maneuvers. All Apache, Black Hawk and Chinook instructor pilot students receive a full day’s briefing about potential air threats on a multidomain battlefield.

Previously, pilots learned this information at their units, but this new approach will ensure consistency throughout the service. Once an instructor completes his or her flight-school course and returns to his/her operational unit, he/she can advise the commander on the skills learned, including how to penetrate a specific radar threat system, for example.

“Now we’re teaching student pilots threats and putting them in the simulator and having them fight and maneuver and survive on a very hostile, high-end battlefield,” Chasteen says.

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Britain is already playing a substantial role in TF-X. Engineers from the UK’s BAE Systems are providing support to the program in Ankara, but Turkish Aerospace (TUSAS) now wants to set up an engineering office in the UK, which, once established, will help support the development efforts of the 3,000 engineers projected to be involved in the fighter project by the mid-2020s.

The expectations for the fighter are ambitious. Assuming Ankara’s political travails around the purchase of a Russian air defense system are ironed out, the TF-X is envisioned to be in service alongside the Lockheed Martin F-35 until 2060-70. Each will also be simultaneously funded.

However, the time table for development of the twin-engine, 60,000-lb.
wider F-35 program would collapse without Turkish involvement, but his words, largely for domestic consumption, do not capture how devastating the loss would be to Turkish products and suppliers. Sales of T129 ATAK attack helicopters to Pakistan are still waiting for U.S. approvals to allow the export of the T800 engine. Delivery of a Turkish-built engine is still more than two years away. Turkey is also considering U.S.-made engines for its TF-X indigenous fighter, Hurjet jet trainer and future attack helicopter.

Yet Turkey shows few signs of swaying toward the U.S. offer to buy the Patriot missile defense system instead of receiving the S-400 as scheduled in July—the same month as a rumored visit by U.S. President Donald Trump.

(27-metric-ton) aircraft has now been nudged quite significantly to the right. First flight is now planned for 2026, three years later than originally envisaged, although TUSAS aims to at least roll out a prototype ready for the centenary celebrations of the Turkish Republic in 2023. Service entry is still slated for the early 2030s.

After several years of confusion around the TF-X’s engine choice, General Electric’s F110 has been selected, an engine with which Turkey is already intimately familiar through local firm Tusas Engine Industries (TEI), which assembles and maintains the F110 for the Turkish Air Force’s F-16 fleet.

The F110 will power the TF-X prototypes, says TUSAS President and CEO Temel Kotil.

The use of the F110 reflects an increase in the power demands for the future aircraft. Previously, TUSAS had been looking at 20,000-lb-thrust-class engines such as the Eurojet EJ200, but company literature now calls for a powerplant in the 25,000-30,000-lb-thrust class—apt for an aircraft that will be similar in size to the Lockheed Martin F-22 Raptor.

Development of a production engine will fall to Ankara-based TR Motor Power Systems, a joint venture of TUSAS and BMC Power Motor—the majority shareholder and part of the larger BMC automotive group. Framework agreements for TR Motor’s work were signed last November, and the company needs to deliver production-standard engines by the early 2030s.

“The [TR Motor] team is working, although it is not full-size yet,” Kotil told Aviation Week during the IDEF defense exhibition in Istanbul in early May. While he is optimistic that the company can deliver an advanced fighter engine in just over a decade, historical precedents suggest that could be a challenge. After all, China has struggled with the advanced metallurgies associated with the high-thrust engines for its Chengdu J-20 combat aircraft. Turkey has more access to skilled international engineering knowledge, though.

“Of course, in a high-technology program, we know many things can cause issues… But the team already has a basic design; they know the fan diameters, temperatures and so on,” says Kotil.

He points to the example of TEI, which is developing a turboshift engine for the indigenous T625 Gokbey utility helicopter. The company is expected to produce a prototype engine in around 30 months, almost three years earlier than the outlined eight-year plan had envisaged.

Two years ago, Rolls-Royce teamed with local company Kale, proposing a new fighter engine using technology from the former’s Trent airliner powerplant, but the agreements with TR Motor appear to suggest a move away from international collaboration. Rolls-Royce and Kale made an improved offer to Ankara last December, which remains in place.

During the IDEF show, TUSAS presented a concept of future cockpit technologies. The company is currently envisioning the use of a single wide-area display like that on the F-35 Joint Strike Fighter, but this would be supplemented by the use of a helmet-mounted sight capable of projecting augmented reality displays, which could be manipulated through hand gestures.

Artificial intelligence would support flight leaders, providing the pilot with data and suggestions on which aircraft in the area would be best suited to attack a particular target.

Turkish suppliers such as Aselsan are working on avionics systems and sensors, including an indigenous active, electronically scanned array radar. Indigenous weapons are also planned, including a small—1000-kg (220-lb.)—modular precision-guided munition called Kuzgun, which is being developed by the Tubitak Sage research and development agency.

TUSAS’ plans call for the TF-X to be preceded by the supersonic Hurjet jet trainer and light-attack aircraft, a model of which was first revealed at last year’s Farnborough Airshow.

“We want to complete the development of Hurjet as early as possible,” says Kotil. “It teaches us about unstable flight, supersonic aerodynamics...
AEROSPACE IN TURKEY

and flight-control systems.”

The internally funded program is seen as a potential replacement for the Turkish Air Force’s Northrop T-38 Talon jet trainers. Recent wind tunnel work has confirmed the configuration of the aircraft; the next step is the preliminary design review planned for the coming weeks. The Eurojet EJ200 and GE F404 are the engine contenders, Kotil says.

To prepare for the next steps of fighter development, Kotil has restructured the company: The fighter program now has its own division.

Last year, the Turkish government invested in development of the production facilities, which will be able to produce 12 aircraft a year. And then at the IDEF event, TUSAS signed agreements with Canadian company Aiolos to build a supersonic wind tunnel to support the TF-X and other future programs. Wind tunnel work to support the TF-X program is currently being conducted in the UK with the Bedford, England-based Aircraft Research Association. Additional facilities, including a radar cross-section range, are also under tender.

Kotil is planning for the British arm to employ 50-100 in the UK and begin hiring soon, he says. Turkish Aerospace has more programs than some of the European OEMs, he points out, “I need good people to support them,” he says.

Greater Indigenous UAV Capability Sought

> TURKISH AEROSPACE DEVELOPED AKSUNGUR IN JUST 18 MONTHS

> MUNITION COMPANIES HAVE DEVELOPED A RANGE OF BOMBS AND MISSILES FOR USE FROM UAV PLATFORMS

Tony Osborne  Istanbul and London

While Europe is finally getting behind the development of multinational medium-altitude, long-endurance (MALE) unmanned aircraft systems (UAS) after years of reliance on Israeli and U.S.-produced systems, Turkish industry is cranking up development of its second and third indigenously developed MALE platforms.

The national development of UAVs, or IHA—Turkish for “air vehicle without man”—has become a point of national pride, particularly for the country’s ruling AK Party, and since the success of a 2015 rapid-arming program for the Baykar Makina Bayraktar TB2 tactical UAS that transformed the use of the platform, with dozens of the systems entering service with the Turkish Army, military police and naval air service. The TB2 has also become an export success, with sales to Qatar and Ukraine.

Last year, after a protracted development, Turkish Aerospace Industries’ (TUSAS) Anka single-engine MALE entered service with the Turkish armed forces. The Anka-S, capable of satellite-based, beyond-line-of-sight control, is in service with the Turkish Air Force, and a secretive version, the Anka-I, has been developed with signals intelligence (sigint) capability to support the work of Ankara’s National Intelligence Organization.

The Anka is currently being used to test an indigenous synthetic aperture radar payload called Sarper, developed by Aselsan.

Use of platforms such as the Anka and Bayraktar—particularly in support of security operations in southeast Turkey and northern Syria—has prompted Turkish commanders and even President Recep Tayyip Erdogan to call for more capable platforms with longer endurance and higher payloads. The first of these is a development of the Anka, the twin-engine, twin-boom Aksungur, which first took to the air in prototype on March 20. The Aksungur was born from the company’s YFYK—for “high useful-load capacity UAV”—first detailed in 2017.

Developed in just 18 months following a board-level decision to first flight, Aksungur was able to leverage existing Anka technology, including the flight-control system and ground control station. The center body is essentially a repurposed Anka fuselage.

The 3.3-metric-ton aircraft is designed to have a 12-hr. endurance at 25,000 ft. with a 750-kg (1,650-lb.) payload and up to 24 hr. at 40,000 ft.

Initial flight testing has been with the German-made Thielert Centurion engine, but the company plans to install the locally developed Tusaş Engine Industries (TEI) PDI70 turbodiesel.

The 2.1-liter, four-cylinder aluminum-cased engine produces 170 shp, and weighs 165 kg, is being flight-tested on the single-engine Anka and made its first flight at the end of 2018.

TEI is looking at a more powerful version of the engine capable of around 220 hp.

TUSAS hopes to finalize testing of the Aksungur toward year-end, with
Cost-Effective Smallsat Launcher Planned

> AIM IS TO ACHIEVE INITIAL OPERATIONAL CAPABILITY IN 2025
> ENGINEERS ARE STUDYING POTENTIAL LAUNCH SITES

Tony Osborne  Istanbul

A nation whose flag features a crescent moon and a star, it is perhaps no wonder Turkey has grand ambitions in space.

It already has a rapidly growing satellite industry, a space agency in the offing, and now it is investing in a launch capability. Development is underway of an indigenous smallsat launcher, to be ready in 2025, while a more capable system, able to lift perhaps 10-15 times more payload, is anticipated later.

Roketsan, which has led the development of Turkish missiles since 1988, is leading work on the Microsatellite Launch System (MUF5S), designed to launch 100-kg (220-lb.) small satellites into a 400-450-km (250-280-mi.) low Earth orbit.

Engineers have been undertaking concept studies for a smallsat launcher capability since 2013, under contract from Turkey's Defense Industry Executive Committee.

Then, last August, Turkey's Defense Industries (SSB) agency gave the green light to establish an initial operational capability for the MUF5S by 2025. In addition to delivering the launch system, Roketsan will build the infrastructure at a coastal site on the Turkish mainland, likely using existing military test ranges. The company is keeping a shortlist of potential sites close to its chest for now.

The MUF5S launcher will be entirely expendable, Roketsan officials told Aviation Week at the IDEF defense show in Istanbul. However, they said, “We are looking to make the design as cost-effective as possible.” Engineers are working on a conceptual design phase. The three-stage launcher will use solid propellants in both the first and second stage, and a more environmentally friendly liquid fuel for the third stage.

The launcher body will be made mainly from carbon-fiber-reinforced composites. The company is also exploring additive manufacturing for the third-stage engine. Roketsan's team of engineers are in the process of optimizing the design, studying options for burn and separation timings, in a bid to finalize the design by year-end.

The launcher is planned to initially provide Turkey with a sovereign indigenous smallsat launch capability before opening the capability up to other nations.

Such a system could pave the way for development of indigenous smallsat constellations.

Turkey is no stranger to the potential of smallsats. In 2003, research and development agency Tubitak Uzay worked with the UK’s Surrey Satellite Technology on Bilsat, a 130-kg Earth-sensing satellite fitted with a multispectral camera for disaster observation.

More recently, Turkish defense company STM has been working on the LAGARi constellation, the country’s first indigenous smallsats, weighing in at around 60-65 kg. STM wants to launch up to eight of the Earth-observation platforms, with the first due to launch this year. The country’s other satellite manufacturers, including Aselsan and Turkish Aerospace are also beginning work on smallsat capabilities, say officials.

Turkish President Recep Tayyip Erdogan approved by decree last December establishment of a Turkish space agency to coordinate the efforts of local companies. Its goals include developing a competitive space and aviation industry as well as expanding the use of space and aviation technologies for the national interest.
The U.S. Export-Import Bank's Revival Is a Boon for Aerospace

Michael Bruno and Ben Goldstein Washington

Some economists say the next recession is a few years off, but the Trump administration already is bolstering the U.S. aerospace industry ahead of the next downturn, now that the U.S. Export-Import Bank is back in business.

A bipartisan majority of senators on May 8 voted to confirm three nominees to the bank’s board of directors, providing the U.S. export credit agency (ECA) a quorum for the first time since 2015. The bank can now resume its multi-industrial $40 billion backlog of deals awaiting approval—at least for four more months.

The nominees, who were appointed and took office May 9, include Kimberly Reed, the Ex-Im's first female president and chair of the board, as well as former Alabama Republican Rep. Spencer Bachus III and Judith DelZoppo Pryor as members of the board.

“I believe that freedom, in the form of free-market principles, is the best way to foster economic opportunity for all Americans,” Reed said at her swearing-in. “As we work together to reopen Ex-Im, I am dedicated to implementing positive reforms in advance of congressional reauthorization. This will allow us to achieve great results for U.S. workers, exporters and the American taxpayer.”

The Ex-Im has been hobbled since 2015, when a Tea Party Republican wave of criticism first kept Congress from regularly reauthorizing the ECA—which it finally did, through this September—and then by keeping a necessary number of board members from being seated, thus limiting the size of individual loan support deals to $10 million.

Among many complaints, opponents of the bank have criticized what they call “crony capitalism,” since much of the Ex-Im’s financial leeway has gone to backing foreign sales of Boeing airliners and other industrial giants’ equipment. The crux of opposition has remained on the political right but also includes Sen. Bernie Sanders (I-Vt.).

Indeed, the vote to confirm the nominees proceeded despite fierce opposition from some Republican lawmakers. Sen. Mike Lee (R-Utah) called the agency “Boeing’s bank” on the Senate floor, criticizing it for sending the OEM 40% of its total funding and 70% of its loan guarantees in 2014, the last full year the bank’s board had a quorum. He said Boeing was the fourth-largest recipient of the bank’s small business funds that year, which “makes you question the vernacular used by Ex-Im bank proponents.”

Sen. Mike Crapo (R-Idaho) also blasted the ECA for providing an “unfair advantage” to beneficiaries over companies that do not receive support, pointing to Air India’s subsidized purchases of Boeing jets as an example. “It’s very nice for Air India. Because they get lower-cost financing on their biggest-ticket items—the jets they fly—they were able to lower the fares they charge on flights from New York to Mumbai. . . . Why do we have taxpayers subsidizing a foreign airline that’s competing directly against U.S. airlines?” he asked.

But others, including Sen. Sherrod Brown (D-Ohio), defended the bank, arguing that a “small group of special interests,” helped by congressional Republicans and the Trump administration, had “paralyzed” the bank, preventing it from fulfilling its mission of supporting U.S. jobs and manufacturers.

Aerospace and other trade representatives have long called for a functional bank. “The Senate’s action today is welcome news to the aerospace industry and to all American manufacturers selling products internationally,” says Dan Dumbacher, executive director of the American Institute of Aeronautics and Astronautics. “We ask that Congress act to reauthorize the bank so it can continue to protect the competitiveness of our domestic aerospace and manufacturing sectors.”

Ironically, the Ex-Im’s revival comes at a time when it is least needed. The combination of U.S. economic strength, the relatively low cost of capital worldwide stemming from low central bank interest rates and an ongoing “hunt for yield” by large investors have led to an upsurge of non-ECA financing alternatives.

Airlines and lessors are expected to have some of their lowest historical costs of financing, Boeing said in
its 2019 Current Aircraft Finance Market Outlook, and lessors continue to be able to rely on capital markets, private backers and bank debt for increased financing. The only funding mechanism that was a concern was ECAs, starting with the Ex-Im (see table).

“Last year saw the expansion of global participation in aircraft financing, increased capacity for pre-delivery payment and mezzanine debt financing, and the continued maturity of the global aircraft financing legal framework; these trends are expected to continue in 2019,” according to the forecast.

Boeing sees a $143 billion aircraft financing marketplace for 2019, up from $126 billion last year. Only 7% of this year’s financing is expected to come from export credit agencies. Bank debt will provide 35%, capital markets 29% and “cash” 26%. Insurance and OEM-provided financing make up the rest.

Nonetheless, Johann Juan, a director in the nonbank financial institutions group at Fitch Ratings, says that in his credit-rating company’s view, the Ex-Im’s return to power still was a credit-positive event for aircraft lessors. This is because government-backed ECAs become extremely important for enabling major export deals such as large commercial aircraft during recessions, when private-sector lending dries up.

“While aircraft lessors have relied more heavily on capital markets funding since the financial crisis, Fitch views the Ex-Im as an important contingent funding option for aircraft lessors with large orderbooks from Boeing, particularly during periods of market disruption,” Juan said May 8.

A potential political fight over the Ex-Im’s reauthorization—needed by Oct. 1, even if short-term—was not the bank’s only unresolved issue. As of the three new board members’ swearing-in, Senate action was pending on two additional individuals nominated by President Donald Trump.

They are Paul Shmotolokha, head of the international division at Alpha Technologies, who was tapped to be the bank’s first vice president, and Claudia Slack, former aerospace and defense executive at General Motors, who was nominated to be a board member.

Kimberly Reed, the Ex-Im Bank’s first female leader, took office May 9.}

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All three manufacturers of purpose-designed, turbine-powered business aircraft in Europe have a key strong point: Business aviation is not their only activity. Dassault Aviation and Pilatus Aircraft have solid defense pillars, and Daher is a conglomerate, with businesses as diverse as aerostructures, logistics and services to the civil nuclear power industry.

A year ago, Dassault CEO Eric Trappier saw the beginning of a recovery in business jets. Since, however, “things have not gone as fast as we would like,” he says.

Falcon deliveries hit a record low in 2018, at 41. Trappier expects 45 deliveries of his company’s business jets this year—all in the large-cabin category. A true acceleration has yet to materialize.

Falcon sales are linked to the global economy, Trappier says, underlining a paradox. The global economy is in good shape, especially in the U.S. and parts of Europe and Asia, he says. But that favorable factor is offset by uncertainties. “Nobody knows what is going to happen in the Sino-U.S. trade war, the euro-dollar exchange rate, the Brexit, the European elections [in late May], the Middle East or the next presidential campaign in the U.S., and investors have a conservative reaction,” he says.

Another question mark for Trappier is whether Chinese companies and entrepreneurs will start buying business jets again. Several factors undermined Chinese demand last year, Jean-Michel Jacob, senior vice president for Dassault Falcon’s Asia-Pacific business, said in February. The overarching one was the slowing Chinese economy, but there was also direction from the government to businesses to keep a low profile and avoid extravagance.

Against that backdrop of slow sales and faltering hopes, Dassault Aviation’s recent acquisition of two major busi-
The PC-24 draws from the PC-12 turboprop—it was designed with short runways and mixed passenger-cargo operations in mind.

Pilatus is enjoying brisk sales of the PC-12 single, at about 80 deliveries per year. “The biggest market is North America, with about two-thirds of all deliveries; the second-largest market is Europe, with close to 20%,” says Gretener.

Daher is also offering business turboprop singles, the lighter TBM 900 family. Chairman Patrick Daher sees the market as rather favorable. “For four years, we have delivered over 50 TBMs per year,” he notes. Despite a slight drop late last year; "due to uncertainties," the pace of 50 per year will be sustained, he says.

The Tarbes, France-based manufacturer is upgrading its aircraft every year. In 2019, improvements include an automated throttle and automatic deicing system, in addition to cabin comfort refinements. The new version is called the TBM 940 and is available along with the lower-cost TBM 910.

Dassault also is updating its range of aircraft. Development of the large-cabin, 5,500-nm Falcon 6X is said to be on time for deliveries in 2022. The first structural parts are being manufactured, and Dassault’s salespeople have begun offering the 6X to customers.

A particular focus has been on monitoring engine development, as repeated delays and technical problems in the Safran Silvercrest program led to termination of the Falcon 5X program. Pratt & Whitney Canada has four PW812D engines under evaluation.

The 6X will herald a new generation of Falcons, with a wider fuselage and significant improvements everywhere. Passenger comfort is expected to be enhanced, thanks to a number of features such as a galley skylight and better pressurization and air conditioning.

The Falcon 6X is to use Dassault’s next generation of digital flight controls. It will be the first business jet to use new flaprons, active high-speed deflection control surfaces that act as both flaps and ailerons. They will improve control during approach, especially on steep descents such as into London City Airport.

The 6X will also mark a step change in using big data analytics for reliability and maintainability.

A future Falcon continues to be studied, but Trappier has not provided details. Given the research and technology work the airframer has been involved in in recent years, it may include improved aerodynamics, with a U-shaped empennage for a reduced noise footprint and a laminar-flow wing or horizontal stabilizer. A new generation of composite materials as well as a fuel cell for the auxiliary power unit may also be in the cards.

Airbus, which offers corporate jet versions of its commercial aircraft, this year started deliveries of the ACJ-320neo family. Based on the A320neo, it can fly 25 passengers, 6,000 nm or 13 hr.

On the operator side, only one company seems to have found a workable business model that helps democratize business aviation, thanks to a fleet of light jets.

Last July, Paris-based Wijet abruptly announced it was relinquishing its air operator’s certificate (AOC). Wijet took over UK-based Blink in September 2016 and began operating 15 Cessna Citation Mustangs under that company’s AOC. Wijet cited Brexit as its reason for moving back to the Continent.

It is now partnering with Luxembourg-based operator Flying Group, which acts as the AOC holder for Wijet’s three HondaJets.

The deeper reasons for the move remain obscure. A structural challenge may have been in the creation of a new market. A solid level of productivity is difficult to reach until a market is active enough, says Olivier Fainsilber, analyst with Oliver Wyman. An aircraft has to be used several times a day to yield enough revenue. Yet limiting the proportion of repositioning flights (i.e., empty legs) is challenging until the right number of aircraft and customers animate the sector.

A new entrant needs deep pockets to wait for that critical vibrancy, says Fainsilber.

In addition to Wijet and Blink, Austria-based GlobeAir is the third operator to have bet on a fleet of light jets in Europe. In 2015, the three considered a merger, where ownership of the new companies would have been split evenly. GlobeAir is the only one still standing as an operator; with 20 Mustangs.
It is a case of Southeast Asia to the rescue. As demand for business jets slumped last year in China, the countries to the south stepped up. The overall Asia-Pacific fleet has barely grown, though trade in secondhand aircraft looks brisk. Notably, quite a few business jets have left China.

The Chinese industry can at least look forward to the easing of its worst operational restriction next year, with the opening of a ground facility at the new airport at Daxing by state-owned Capital Jet.

Southeast Asian countries collectively added a net 14 aircraft to their fleets in 2018, a 6% increase, according to a comprehensive annual report compiled by Hong Kong consultancy Asian Sky Group. Mainland China, Hong Kong, Macau and Taiwan—counted together as Greater China—stagnated.

Singapore has led growth in Southeast Asia and indeed across the whole Asia-Pacific region, though to some extent it is only bouncing back from a 2017 contraction. "The country, which has positioned itself as a hub for business aviation, is finally showing the positive effects of facilities catering to the industry in the form of an increasing fleet size," says Asian Sky.

Greater China figures reveal considerable churn: 47 aircraft left that zone, more than offsetting arrivals, which included 13 secondhand aircraft. When the Chinese market began growing briskly around the beginning of this decade, the industry did not expect buyers would be much interested in used aircraft. A healthy U.S. market has helped absorb the disposals from China, industry officials say.

Mainland China, Hong Kong, Macau and Taiwan are counted as one market because so many mainland owners keep their aircraft in surrounding territories; together they have the largest Asia-Pacific business-jet fleet. Prominent operators in the zone have gone through large reductions in their fleet size, says Asian Sky. "The slowed fleet growth can be seen as a warning sign of decreasing economic activity amidst increasing tensions with the U.S. regarding the trade war." Economics are not the only factor; however. Others include a clampdown on ostentation and difficulty in securing foreign currency for a purchase (AW&S April 8-21, p. 31).

This appears to have hit Gulfstream more than its rival Bombardier. The U.S. manufacturer has long been the strongest in China. As the overall fleet growth in China has fattened, so has the number of Gulfstream aircraft across the Asia-Pacific region: It rose by just one in 2018. Bombardier, with a wider geographic spread of sales, continues to see healthy growth, with

Meet the Comac Business Jet—an ARJ21 Version

Comac is building the first aircraft of the ARJ21 regional jet’s corporate version, intending to complete it next year as a demonstrator to show prospective customers. Called the Comac Business Jet (CBJ), the variant features an additional fuel tank in the center wingbox.

The state company is highlighting the spaciousness of the CBJ, a characteristic inherited from the unusually wide fuselage of the ARJ21, which is designed for five-abreast economy seating.

No orders for the CBJ have been taken, says Comac’s deputy director of marketing and sales, Yang Yang; a demonstrator is needed first and will be ready in 2020. Fokker Technologies has helped the company develop the interior, Yang said at the Asian Business Aviation Conference and Exhibition, held here in April.

A corporate version of the ARJ21 has long been part of Comac’s planning. Over the past decade, it has often shown models of the concept at air shows, but engineers could presumably make little progress with it before the type entered airline service. That did not occur until June 2016, about 14 years after development was launched.

Comac is marketing the CBJ mainly domestically, Yang said.

With the additional tank and the light passenger load of a private aircraft, the CBJ has a range of 5,500 km (3,400 mi.). Since it is based on a commercial aircraft intended for short missions, the typical cruise speed is modest by
19 aircraft added in the Asia-Pacific fleet in 2018, ending at 328. Dassault's numbers were unchanged.

Altogether, the Asia-Pacific region, of which Australia has the second-largest fleet, grew just 1.4% to 1,201 in 2018.

Capital Jet’s fixed base of operations at Beijing’s current airport, Capital International, handled 9,000 aircraft movements and more than 30,000 passengers in 2018, which makes it the largest ground-support operation for business aviation in China, the company says. But Capital International is the country’s busiest airport and is operating beyond its designed capacity pending the opening of Beijing Daxing International. Runway slots and parking space are both in short supply.

Capital Jet, also known as CJet, belongs to Capital Airport Holding Co., the state company that is the operator of both airports and also a major shareholder in them.

Daxing International is due to open no later than Sept. 30, 2019. Capital Jet says it will start operations there in 2020; it does not offer more specific timing. The company will have an 8,000-m² (86,000-ft²) terminal with a 110,000-m² ramp exclusively for business aviation use. That includes 85 parking stands, 15 for type C aircraft such as standard narrow-body jets and two for type Es—that is, those up to the size of a Boeing 777.

“Further, five business aircraft hangars totaling 20,000 m² will be constructed for short- and long-term parking,” providing enough space for 15 Gulfstream G650s, the company says. A maintenance hangar will have an area of 7,000 m².

Like Shanghai Hawker Pacific, Capital Jet has been economizing on parking space by using dense arrangements previously unavailable in China. At Capital International it has increased its parking spots by 12—or 20%. It has also tested high-density parking of business aircraft in spaces primarily intended for large commercial aircraft.

Million Air of the U.S. is a partner of Capital Jet in operating the facility at the old airport.

The ARJ21-based CBJ has a wider cabin than other regional jets adapted as private aircraft.

Business aviation standards: Mach 0.78.

But, in common with adaptations of some other regional jets, the CBJ has the advantage of aft engine mounting, helping to minimize noise in the cabin. The noise level will be as low as 55 dB, according to Comac. The ARJ21 is powered by the General Electric CF34-10A engine. Another advantage for private users is the regional jet’s suitability for operation from hot-and-high airports, a requirement driven by Chinese airline operations.

“Since 2018, Comac has communicated with a number of potential customers [about the] CBJ business jet and conducted in-depth discussions on aircraft purchases, subsequent operation modes and support programs,” the company says.

Because Comac is new to business aviation, it faces an uphill challenge to persuade prospective buyers that it can make and support a suitable private aircraft. But a powerful, unstated selling point is the political advantage a Chinese buyer can gain by being seen to support Comac. That factor is helpful for Comac when it seeks orders for commercial aircraft, too.

The CBJ cabin is 3.14 m (10.3 ft.) wide and 2.03 m high, compared with the 2.74-m width and 2.0-m height of the Embraer E-Jet, on which that company’s Lineage corporate aircraft are based. The Chinese aircraft’s cabin is 19.04 m long and has a floor area of 54 m² (580 ft²) and volume of 110.96 m³ (3,919 ft³).

The CBJ can be fitted with bedrooms and spaces for meetings, rest, dining and reception, Comac says. The company is also offering an “advanced interactive entertainment system.”

The Comac aircraft’s considerable width ultimately derives from the DC-9, which is also 3.14 m wide internally. The MD-80 and MD-90 versions of the U.S. aircraft were built in the 1980s and ’90s by an Avic factory in Shanghai that later became part of Comac. ARJ21 designers referred to the MD-90 as they developed their regional jet, though no parts are common between the two types.

In commercial operation, ARJ21s have accumulated a total of more than 10,000 flight hours and carried more than 320,000 passengers, Comac says.

The initial commercial version, on which the CBJ is based, is the ARJ21-700. Comac is planning to lighten the aircraft, too.

The ARJ21 began operation as a commercial transport with its second customer on Feb. 22, when newly established Genghis Khan Airlines used an aircraft of the type for a service between Shanghai and the carrier’s hometown, Hohhot, Inner Mongolia. The first operator was Comac subsidiary Chengdu Airlines, which had received 11 ARJ21s by the time Genghis Khan took delivery of its first.
Some observers characterize the modern airline industry as a struggle between the legacy giants and the low-cost upstarts. However, the reality is much more nuanced than that. In Asia, a substantial share of the LCCs are in fact subsidiaries of the full-service carriers (FSC), as they look to defend their turf and appeal to a wider range of customers.

This dynamic has implications for manufacturers and lessors. In many cases it gives FSCs an avenue to deploy their used aircraft as they are replaced. But new opportunities for aircraft orders or leases are also emerging, including types not already operated by the parent. This can be significant, as the subsidiary’s growth rate is often more rapid than that of the legacy operation.

Recent business forays by three airlines in different parts of Asia demonstrate the dual-model momentum is continuing. Cathay Pacific has decided to buy struggling budget airline Hong Kong Express (HKE), and Japan Airlines (JAL) is preparing to introduce a new long-haul LCC subsidiary, Zipair Tokyo. In Central Asia, Air Astana has launched its own LCC offshoot, FlyArystan.

New efforts by Asian airline groups to establish or take over low-cost carriers (LCC) show that the trend of full-service airlines entering the budget sector is alive and well. As the old saying goes, if you can’t beat them, join them.

Of course, there are still many LCC players in Asia that are not aligned with full-service parents. The most notable are AirAsia and Lion Air, the largest LCCs in East Asia. These airlines have spread their influence by setting up offshore joint ventures in other countries. However, the introduction of new franchises by independent LCCs has slowed to a trickle in recent years. Even expansion-addicted AirAsia has announced it will take at least a three-year break from starting new offshoots.

The trend of full-service airlines owning—or part-owning—LCCs is more prevalent in Asia-Pacific than in other global regions, although it is also fairly common in Europe. It has developed to the point in Asia where legacy airlines choosing not to go down this path are becoming the exception rather than the rule. According to a recent report by CAPA – Centre for Aviation, there are no less than 17 full-service airline groups in Asia-Pacific that have LCC subsidiaries or affiliates.

Until recently, the most notable holdout was Cathay Pacific. Its leaders had previously argued that they could appeal to both ends of the market by leveraging its massive seat inventory in its existing aircraft fleet. This was in marked contrast to rival Singapore Airlines, which set up both long-haul and short-haul LCC operations.

Cathay had shown signs of reconsidering in recent years, with executives conceding they would not rule out entering the LCC market if the right opportunity presented itself. That opportunity arose early this year with HKE.

On March 27, Cathay reached a deal to buy HKE in an acquisition valued at HK$4.93 billion ($628 million), comprising HK$2.25 billion in cash and a noncash component of HK$2.68 billion in a promissory loan note. HKE was previously controlled by China’s HNA Group, which has been attempting to unload assets to strengthen its financial health and resolve liquidity concerns.

When Cathay first signaled in early March that it was considering buying HKE, its motives were unclear. Some observers believed Cathay was mainly interested in obtaining HKE’s valuable airport slots and would shut down the carrier. Others surmised it was primarily a blocking action to prevent a rival taking over the LCC.

However, when it announced the purchase decision, Cathay made it clear it would “continue to operate HKE as a stand-alone airline using the low-cost carrier business model.” Such a move is “an attractive and practical way for the Cathay Pacific Group to support the long-term development and growth of its aviation business and to enhance its competitiveness,” the company said.

What the HKE deal represents is an opportunity to immediately step into the LCC segment without a laborious launch process or the need for a joint venture with another LCC. It also does not require Cathay to give up any of its
own slots at Hong Kong International Airport, which is severely constrained until its third runway is completed.

The takeover solidifies Cathay’s leadership in Hong Kong. Cathay has a 45% share of the Hong Kong market, and HKE 6%, according to CAPA data. Cathay is “not late to the game” in launching an LCC, because Hong Kong still has a relatively low LCC penetration rate of 12%, CAPA stated in a report.

While other LCCs serve Hong Kong, HKE is the only one actually based there. Cathay opposed Jetstar’s attempt to launch an LCC joint venture in Hong Kong, with the joint venture rejected by regulators in 2015. The HKE acquisition is due to close by Dec. 31, assuming relevant regulatory approval. Aviation Week’s fleet database lists HKE with eight Airbus A320s, five A320neos, and 11 A321s, all of which are leased.

Air Astana’s LCC subsidiary FlyArystan began operations May 1, initially serving six Kazakhstan domestic routes with two A320s. The carrier will add another two by October; Air Astana CEO Peter Foster tells Aviation Week. The arrival of these subsequent aircraft will allow the LCC to launch its first short-haul international operations.

The LCC will grow quickly, Foster says. Air Astana plans for its subsidiary to have 10 aircraft by the end of 2020 and 15 by the end of 2021. While the initial four aircraft will be transferred from the parent’s fleet; the next additions will be leased A320s or A321s. The airline will probably look to place its own orders in the long term.

Air Astana is already looking to establish overseas affiliates of FlyArystan in neighboring countries. It aims to have firm plans for such a move in place later this year, with the first offshoot launching in mid-to-late 2020, says Foster.

This planned rapid development is due to the huge potential for LCCs in Central Asia and the Caucasus, Foster says. While there are Eastern European and Middle East carriers flying into the region, no other LCCs were based there until now. Air Astana recognized the importance of “gaining first-mover advantage,” as there is “clearly a huge gap” for LCC service in the region, he says.

FlyArystan has been set up under the Air Astana air operator’s certificate (AOC), although it is working on securing its own. It aims to achieve this by January 2020.

Air Astana does not regard itself as having a dual model, since the two operations are complementary but will be run separately. Many airlines have discovered it is best not to “micromanage” the development of LCC subsidiaries, notes Foster. He believes the parent must “allow the LCC to grow organically” and respond to the market, and therefore he is “reluctant to hold back the LCC” as it plans routes.

This means there will inevitably be some degree of route overlap between the parent and subsidiary, Foster admits. However, he says there are also plenty of secondary routes with “huge demand” that are currently not being served by full-service carriers.

Foster says Air Astana considered partnering with an established LCC in a joint venture as some other airlines have done, but eventually decided against such a move. He says that rather than “giving the store away” to another LCC partner, Air Astana hired executives with LCC expertise to run the subsidiary. It also transferred some of its own managers.

Although airline industry earnings are beginning to come under pressure globally, this is still a good time to launch the LCC, Foster contends. “History has shown that when times are tougher and traffic starts to flatten—which is clearly the case now—it is the LCCs that profit [most],” he says. “We think the timing is ideal.”

JAL, meanwhile, intends to launch medium- and long-haul LCC Zipair Tokyo in the summer of 2020. Next year is a significant one for the Japanese airline industry, with new capacity expected to be made available at the two main Tokyo airports and an influx of tourists coinciding with the Tokyo Olympics. Zipair will obviously be an important part of the JAL Group’s growth plans for 2020.

The LCC is expected to start with two Boeing 787-8s, operating medium-haul routes from its Tokyo Narita hub to Bangkok and Seoul’s Incheon Airport. The initial 787s will be leased from JAL, with their configuration likely to be announced later this year. Zipair plans to add two aircraft to its fleet every fiscal year. This means it expects to have four 787s operating in 2021.

JAL has said that Zipair will eventually operate to longer-haul destinations in Europe and the U.S. in addition to Asian markets. The airline will introduce true long-haul flights once it acquires ETOPS certification, a JAL spokesman says. While dates and routes have not been revealed, the carrier plans to be flying long-haul within 2-3 years.

Zipair applied for its own AOC in March. The carrier’s president, Shin-go Nishida, is a former senior exec-
South Korea Primed for Narrowbody Influx

> DESPITE DELAYS, AIRLINES ARE SET TO REFRESH SINGLE-AISLE FLEETS
> NEW LCCS WILL LIKELY BOOST NARROWBODY GROWTH IMPETUS

Adrian Schofield Auckland

South Korean airlines are driving major changes in the country’s narrowbody fleet, as startup carriers emerge and existing players prepare to receive a wave of new-generation models.

Korean Air intends to introduce Airbus A321neos and Boeing 737 MAXs, although first deliveries of both types have been delayed. Asiana Airlines also has A321neos on order, while low-cost carrier (LCC) Jeju Air has ordered up to 50 Boeing MAX-family aircraft. In another notable development, the South Korean government has approved three LCC startups to enter service, two of which will operate narrowbodies.

South Korean airlines collectively have 129 narrowbody aircraft on order, compared to just 22 widebodies, according to Aviation Week’s fleet database. The narrowbody orders comprise 74 MAX aircraft and 55 A321neos, and more are expected to be added via deals with lessors. While the timing of the MAX deliveries is uncertain due to the worldwide grounding of the type, South Korea is still set for a significant overhaul of its narrowbody operations.

Asiana’s 25 A321neo orders are due to begin arriving in July, although the carrier stresses this target is subject to change. They will mainly be used to replace the 18 A321s the airline currently operates.

While Asiana has been under severe financial pressure, the airline confirms it still intends to take all 25 of the Neos. If anything, the airline’s predicament makes the fleet upgrade more important. In addition to route cuts, Asiana’s recovery plan has an increased focus on phasing out aging aircraft and replacing them with more efficient types.

Korean Air has orders for 30 A321neos and 30 737 MAX 8s. Deliveries were expected to begin around midyear, but Korean has been confronted with delays for both types. The first MAX deliveries were scheduled to arrive in May. However, it became apparent in March that this would not occur, due to the grounding of all MAX-family aircraft following two fatal crashes. Revised delivery time tables for Korean Air and other customers cannot be set until regulators approve software and training modifications and clear the MAX for operations.

Korean Air was due to receive six 737 MAX aircraft this year, and it has had to schedule other aircraft types on routes where they were to be deployed. The airline says it can delay the retirement of its existing 737 fleet to mitigate the MAX delays.

Delays have also struck Korean’s A321neo deliveries. The carrier was expecting to receive the first of these in July and a total of five by the end of December. However, the target for first delivery has been pushed back to April next year, with seven to arrive in 2020.

The MAX and Neo deliveries are intended to begin the replacement process for Korean’s fleet of 33 737NGs, although they will also provide fleet growth for the airline on short-haul international routes to China, Japan and Southeast Asia.

In another narrowbody development, Korean Air this year received the last of its 10 Airbus A220s on order. These are mainly used on domestic flights and on Korean’s extensive Japanese network.

Jeju Air has placed the largest Boeing narrowbody order among South Korean carriers, with 40 firm orders due for delivery in 2022-26 and 10 options. The carrier has selected the MAX 8 version, although some may be swapped for 10s.

Jeju is the biggest of the LCCs in the South Korean market, operating more than 40 737-800s. The MAX deliveries would allow it to extend its range and upgauge existing routes. The 737-8 would add 650 nm to the range of the -800s, and the -10s would have 41 more seats than the current fleet.

LCC Eastar Jet is another airline updating its fleet with MAX aircraft, and it was the first of the South Korean carriers to take delivery of a new-generation narrowbody. The carrier had received two 737-8s before the groundings and has four remaining on order.

While it has no orders listed, rival LCC T’way Air has previously discussed adding several 737 MAX aircraft. These would presumably be leased.

Two more narrowbody operators are planning to launch service in 2020—Aero K and Fly Gangwon. These were among the five prospective LCCs the South Korean government was considering for approval. Both were granted business licenses in March, along with widebody LCC Air Premia. They still must obtain air operator certificates.

Aero K will be based in Cheongju in central South Korea. The carrier is targeting the first quarter of 2020 for its first flights, with initial service to Japan and other short-haul international destinations. It will begin operations with three Airbus A320s it has ordered and plans to lease others.

Fly Gangwon will be based in Yangyang, in the northeast of South Korea. It intends to operate Boeing 737-800s and will initially target routes to China, Japan and the Philippines, according to South Korea’s transport ministry. ©
Asian Pacific Aviation

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The JAL Group has already invested in the country’s narrowbody fleet, as startup carriers in South Korea are driving major changes in ownership share, with the Qantas-JAL Group stresses that route, policy and management decisions will be made independently.

Jeju Air has placed the largest Boeing narrowbody order among South Korean carriers, with 40 firm orders due for delivery in 2022-26 and 10 options. The carrier has selected the A321neo for most of its new-generation models.

The carrier was expecting to receive the first of these in July and the remainder by other Japanese companies. However, the JAL Group has not confirmed any codeshare arrangements yet, although there could be some degree of cooperation with Jetstar Japan, also based at Narita.

Despite delays, airlines are set to refresh their single-aisle fleets. Despite delays, airlines are set to refresh their single-aisle fleets.

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Korea Aerospace Industries (KAI) is close to the assessment phase of a study for a new commercial aircraft. The company says it will lead development of the type, which it has previously identified as a regional airliner.

Separately, KAI expects within weeks to confirm a preliminary agreement to take over manufacturing of Gulfstream G280 wings for Israel Aerospace Industries (IAI), the manufacturer of the business jet. In a reportedly related move, the company is moving to build a new civil factory.

KAI CEO Kim Jo-won said in February the company aimed to build a foreign civil aircraft, under license beginning in 2023 while also developing its own 60-seat design for sale in 2030; the choice between turboprop and turbofan propulsion was not mentioned. These programs would be part of an effort to start to shift away from military production this year. Sales of manned combat aircraft will become difficult, but the civil market will continue to grow, Kim says.

The CEO did not say the licensed-built civil type would be a commercial aircraft, and two spokespeople for the company, describing KAI’s strategy in answer to Aviation Week questions, gave no update on that prospective program. They did, however, refer to the regional airliner.

“KAI is engaging [in] a preliminary feasibility study and market research activities along with [another] institution for a full-scale passenger-aircraft development,” says one spokesperson, adding that KAI and its unnamed partner are assessing the scale and sustainability of demand domestically, in Asia and further afield.

Although the South Korean company will get some components from risk-sharing partners, “KAI will take the lead in the development,” says the other company representative, emphasizing that no go-ahead decision has been made. Exploratory development of the 60-seater will be completed by 2022, Kim says in interviews with South Korean media.

The prospect of rising South Korean demand for air travel is one reason to move into making complete civil aircraft, the CEO says, seemingly implying the company would have the lead in the development, “says the company, describing KAI’s latest plan to build a complete airliner. The ministry is instead envisaging a regional jet, the KRJ. Though details were not released, the proportions shown in a simple official drawing suggested a four-abreast fuselage suitable for stretching to around 100 seats. It had a T-tail configuration, like the Bombardier CRJ.

The Korea Herald describes the current KAI design as being in the 50-70-seat class. The company aims at selling 150 units in South Korea and gaining revenue of 12 trillion won ($10 billion), the newspaper says. This implies most production would be exported.

Kim appears to have limited confidence in the exportability of the KF-X. South Korea requires 120 fighters of the type, while partner Indonesia reportedly wants 50. Development is scheduled to be completed in 2026.

In contrast with its backing for earlier aircraft projects, the industry ministry is notably silent on KAI’s latest plan to build a complete airliner. The ministry is instead encouraging the industry to take on risk-sharing projects—that is, work for other companies in which the South Korean supplier is fully exposed to the sales volumes of the aircraft.

The G280’s current wing-maker, Triumph, said on April 5 it had agreed with IAI on the “transition” of the manufacturing work. Where it was transitioning has become apparent: KAI says at about the same time it signed a memorandum of understanding worth a reported $529 million covering manufacturing of the wing until 2030. The deal reportedly envisages delivery of 300 sets. A definitive contract is expected after a couple of months, the second spokesperson says, so it should be signed by early June.

KAI says it will set up a new factory for making and assembling civil components at Goseong, 30 km (20 mi.) from its main plant at Sacheon. A local newspaper, the Gyeongnam Daily, says the G280 wing will be built there.
Korean Air Aims for Advanced Composites Manufacturing

OUT-OF-AUTOCLAVE TECHNOLOGY IS A FOCUS
ASTK IS CONTRACTED TO BUILD EMBRAER E-2 FUSELAGES

Bradley Perrett  Beijing

Korean Air’s Aerospace division thinks it knows how to make some aircraft parts well. It does not show much interest in making new varieties of products; rather, its attention is clearly on making the same sorts of things at lower cost—and predominantly from carbon fiber.

A step down in the South Korean supply chain, privately held AeroSpace Technologies of Korea (ASTK), a maker of metallic components for first-tier suppliers, is meanwhile stepping up its business with an agreement to build Embraer E-2 fuselages on behalf of Triumph. Also, Korea Aerospace Industries (KAI) is looking at building more complete civil aircraft (facing page).

Korean Air makes the Boeing 787 aft body with automated fiber placement to create a skin over integrated stringers.

As Korean Air works to advance and sustain its manufacturing business, its specific focus is on nonautoclave curing, integral carbon-fiber structures and further automation. The company says it aims to apply such technologies in programs similar to those it is already undertaking.

The aerospace division of Korean Air makes parts for such aircraft as the Airbus A320 and A350 and Boeing 737 and 787, in some cases as a contractor to other suppliers. With five contracts, the 787 program is its largest. It includes the company’s most sophisticated commercial-aircraft manufacturing activity, building carbon-fiber composite skins with integrated stringers for the aft fuselage, called Section 48. These are made by loading the stringers into a one-piece tool, which Korean Air developed, then laying up the skin on them with automated fiber placement.

The main technological aim is applying out-of-autoclave processes to curing composites, specifically those of integral design, such as the 787 aft fuselage, the company tells Aviation Week. Another direction is toward achieving automated assembly of parts.

Many manufacturers are working on new or improved ways of making carbon-fiber parts without using autoclaves, thereby avoiding the considerable cost of buying and running the huge pressure cookers. Korean Air declines to disclose the specific technologies it is looking at, however.

It does not rule out moving into parts dissimilar to those it now makes. But the company emphasizes the potential cost competitiveness and profitability in applying new technologies to making structures similar to or derived from those with which it is already familiar. Examples include doors, control surfaces, wingtips, vertical and horizontal stabilizers and rear fuselages. Korean Air makes wingtips, tip extensions or winglets for the Boeing 737, 747, 777, 787 and Airbus A320 and A330. It also makes A350 cargo doors.

As to products in unfamiliar types, the company points to the possible preference of buying rather than developing and making them.

Within the South Korean industry, Korean Air has traditionally had a greater focus on build-to-print contracts; KAI, with much of its business military-based, has had a greater engineering capability. The gap may have narrowed. “Korean Air has been expanding capabilities in design and development of composite structures, through the 787 design and development project in 2005 and the design and development projects of A320 sharklets and A350 cargo doors,” the company says.

In an industry subject to relentless competition and falling prices, expansion does not appear to be Korean Air’s primary goal. “While increasing revenues is also important, our target is to acquire sustainability based on stable profitability and innovative competitiveness,” it says.

ASTK, meanwhile, has gained a major expansion of its business. Following a preliminary agreement last year, Triumph said in April it had assigned
Before parent company United Technologies Corp.’s (UTC) $30 billion acquisition of Rockwell Collins closed last November, U.S. antitrust regulators required UTC to divest the latter company’s pneumatic deicing boot business in Fenwick, West Virginia, and the manufacture of trimmable horizontal stabilizer actuators (THSA) in Irvine, California, and Mexicali, Mexico. In February, France’s Safran acquired the Rockwell Collins electromechanical systems business, consisting of the THSAs and pilot controls.

Upon its merger with UTAS, Collins Aerospace was reorganized into six strategic business units: avionics, aerostructures, interiors, mechanical systems, mission systems, and power and controls. Two legacy UTAS business units—Rosemount Aerospace and Kidde Fire Protection—were moved into the avionics unit, which also assumed responsibility from its sister mission systems unit for Collins Elbit Vision Systems, the joint venture with Elbit Systems of America that builds the helmet-mounted display system of the Lockheed Martin F-35 Lightning II fighter.

The legacy avionics business that supplies a wide array of electronics for major aircraft manufacturers remains intact. Nevertheless, Kent Statler, the first executive to lead the Collins Aerospace unit, described the company as being at a transition point. (Shortly after this interview, Collins announced Statler’s retirement, after 32 years with the company. Steve Timm, who led the commercial avionics portfolio, succeeded Statler, effective May 9.)

Statler listed several avionics programs on aircraft that have reached production, leading to a shift in focus to updates and new developments. These programs include the 15.1-in. flight deck liquid crystal displays (LCD), dual head-up displays (HUD), pilot controls, core network, radios and integrated surveillance system.

Bill Carey Cedar Rapids, Iowa

Except for some office shuffling at its campus here, the removal of “Rockwell” from signage and the departure of CEO Kelly Ortberg for new executive offices in West Palm Beach, Florida, Collins Aerospace’s core avionics business appears much the same following the company’s merger with UTC Aerospace Systems (UTAS).

EYES FORWARD

> COLLINS SHIFTS FOCUS TO AVIONICS UPDATES
> SHIPSETS DELIVERED FOR BOEING 777X
> NEW PRODUCTS INCLUDE DIGITAL HF RADIO
The Bombardier Global 5500 and 6500 large-cabin, long-range business jets are launch platforms for the Collins combined vision system, which fuses enhanced vision and synthetic vision within the company’s head-up guidance system.

with MultiScan weather radar on the Boeing 787; the large-format displays, multimode navigation receiver and other systems on the Boeing 737 MAX; the avionics full-duplex switched Ethernet data network, communications and other systems on the Airbus A380 and A350XWB; and the flight operations and maintenance exchanger (FOMAX) on new Airbus A320s and A330s.

(Collins also supplies the flight-control computers and Rosemount provides the angle-of-attack vanes on the 737 MAX, respectively, systems that host software and feed data to the Boeing Maneuvering Characteristics Augmentation System implicated in the Lion Air and Ethiopian Airlines 737-8 crashes. Collins referred questions on the systems to Boeing. Discussing the overall effect of Boeing’s 737 MAX production slowdown during a first-quarter results call April 23, United Technologies Chief Financial Officer Akhil Johri said Collins expects up to a 10-cent-per-share hit to its earnings this year.

Among the systems Collins is supplying on Boeing’s new 777X are the 787-derived flight deck LCDs, optional dual HUDs, SSR-9000 Avionics Gateway secure server router, integrated surveillance system and (with BAE Systems) the Integrated Flight-Control Electronics, a fly-by-wire system that will manage the aircraft’s new wing surfaces and folding wingtips.

Boeing rolled out the first 777X for employees at its Everett, Washington, facility on March 13. As of Aviation Week’s visit in mid-April, Collins had delivered avionics shipsets for four of the new widebody airliners. The flight deck LCDs—four across the instrument panel and a fifth centrally mounted—will be the air transport industry’s first touch-screen displays, which Boeing selected after testing touch screens on its 2014 EcoDemonstrator flying testbed.

Collins has delivered “production-ready displays, but they haven’t gone full black-label,” or into full-rate production, Statler said. “We have a red-label version, which means they are safety-of-flight ready, but we don’t close out all of the certification documentation until they are through flight test.” Boeing expects to conduct the first flight of the 777X in the coming weeks.

Development of the large-format LCDs on the 787 and 737 MAX has produced a robust aftermarket opportunity for the avionics manufacturer: the Collins Large Display System (LDS) retrofit for the Boeing 757 and 767. The system replaces six cathode-ray-tube displays and various analog instruments with three 15.1-in. LCDs that can be scaled in capability to render synthetic vision of terrain and infrared (IR) enhanced vision.

The company has 250 aircraft—190 767s and 60 757s—under contract for the retrofit, Statler said. The system was installed on 90 of those aircraft across four carriers. One customer is cargo carrier UPS, which last year announced plans to retrofit the LDS on 147 757/767 freighters. Another reported customer is rival FedEx Express.

“We’ve just been [working] one program after another. Now we’re through a vast majority” of development programs, explained Statler. “We’re transitioning to a time to update our sensor and radio suites.”

Forward-looking developments focus on automation and what Statler called a “connected ecosystem” that integrates ground and airborne systems. “One of the biggest things on Day 1 at the close of the [UTAS] transaction was kicking off our joint strategies around that. You’re going to be hearing more very soon of what we’re doing around the connected ecosystem,” he said.

The Rockwell Collins acquisition of Annapolis, Maryland-based ARINC, now the Collins Information Management Services (IMS) business, for $1.4 billion in December 2013, figures prominently in the Collins Aerospace vision of connectivity.

By acquiring ARINC, the company inherited a global air-to-ground communications network for aircraft communications addressing and reporting system (ACARS) messaging by very-high-frequency (VHF), long-range high-frequency (HF), and Iridium and Inmarsat L-band satellite communications (satcom), with contact points at airlines and airports.

“For most of the recent generation of aircraft, Rockwell Collins had provided what we call the ‘onboard enablement’ platforms—the core network on the 787, the IMO [information management onboard] system for the A350, FOMAX for A320neos and work we’re doing on 777X with the avionics gateway,” Joel Otto, Collins head of connected airplane digital strategy and business development, explained during a 2018 briefing.

“We saw the market was looking for something broader and solutions that deliver the value and capabilities [airlines] were looking for,” Otto added. “We brought together ARINC and Rockwell Collins to be able to build out those total sets of solutions.”

An example of an end-to-end connectivity solution is the Collins FOMAX data-capture and transmission module, which supports the Airbus Skywise data platform for predictive
maintenance and airline operational analysis. The secure router is a standard line-fit component on new A320s and A330s, replacing the Electronic Flight Bag Interface and Communications Unit on those aircraft, which was optional equipment.

FOMAX captures roughly 24,000 aircraft parameters, says Airbus, which launched Skywise at the Paris Air Show in June 2017. Building on Collins’ SSR-7620 Secure Server Router, it collects performance and maintenance data and connects to ground infrastructure by satcom including L-band and Ka/Ku-band satcom, VHF/HF, ground Wi-Fi or cellular links.

Airbus announced AirAsia, Asiana Airlines and Etihad Airways as the first carriers to sign predictive maintenance contracts for Skywise analytics support. They also gained access to Skywise Core, a cloud-based platform allowing airlines to access and analyze selected Airbus data together with their own operational, maintenance and aircraft data. The airframer offers Skywise Core access to airlines that agree to share operating data from their Airbus fleets.

“That’s where we’re excited from an avionics perspective; we’re right in the middle of that with the secure routers, with the [transmission] tubes, with the IMS network on the ground,” said Statler. “We’re in talks with several airlines about how we can enable them to improve their operational [performance] and responsiveness to issues as they happen.”

Among newer avionics on which Collins is focused are a combined-vision HUD, multimode satellite-navigation receiver, Iridium Certus terminal and digital HF radio.

Craig Peterson, Collins Aerospace vice president for avionics marketing, describes combined vision as a progression in head-up piloting technology. It starts with the basic HUD with flight symbology and flightpath vector superimposed on a transparent combiner screen positioned at the pilot’s eye level. Next up is installation of dual HUDs, for shared situational awareness by the captain and first officer.

Adding imagery from a nose-mounted IR camera provides an enhanced vision system (EVS) rendering of the view of the outside world. Finally, a combined vision system (CVS) interweaves EVS and SVS to present pilots with a more detailed view of the runway.

“With our constantly updating algorithms, we can pull out all the macro benefits of the two systems and diminish the shortcomings of the two technologies,” says Peterson, explaining that an IR sensor is susceptible to environmental factors such as heavy rain, sleet or snow, and are databases to miscodings or data errors.

“We’re doing constant algorithmic weighting and balancing and blending of those two pictures, monitoring contrasts,” Peterson says. “As environmental factors such as clouds or rain or sleet shroud one technology, [the CVS] will weight toward the other to keep a complete picture in front of the pilot.”

At the Farnborough Airshow in July 2018, Collins announced the Bombardier Global 5500 and 6500 large-cabin, long-range business jets as CVS launch platforms. Months later at the National Business Aviation Association annual conference, Collins said it would supply its HGS system—fusing EVS and SVS with the Pro Line Fusion flight decks—on Embraer’s new Praetor 500 midsize and Praetor 600 super-midsize business jets.

Regulatory authorities now allow operational credits for Part 121 aircraft fitted with HUDs and infrared sensors, Peterson notes. The FAA allows Enhanced Flight Vision System operations using HUDs and imaging sensors “in lieu of natural vision” to dispatch an aircraft when the forecast visibility at its destination is below minimums and to begin or continue an approach when reported visibility is lower than instrument approach procedure visibility minimums.

The Civil Aviation Administration of China requires all China-registered air transport aircraft to be equipped with HUDs by 2025, a phased mandate that...
includes implementation of the EVS.

Collins’ GLU-2100 Multi-Mode Receiver (MMR) entered service last summer on the 737 MAX, with the A320neo to follow. The navigation receiver uses software-defined radio technology and is capable of handling multiple frequencies from multiple satellite constellations.

decode capability,” says Peterson.

In addition to being multifrequency and multiconstellation-capable, the GLU-2100 product roadmap calls for Ground-Based Augmentation System Category 2/3 and SBAS localizer performance with vertical guidance precision approach capabilities, both of which are being developed for entry

Collins was evaluating whether to develop its own hardware or to partner with another manufacturer for Inmarsat’s rival SwiftBroadband-Safety offering, which uses geographic spot-beam technology over Inmarsat I-4 series geostationary satellites to focus signal energy. Collins IMS is a value-added reseller of Inmarsat con-

Initially developed to provide Satellite-Based Augmentation System (SBAS) position accuracy and integrity for automatic dependent surveillance-broadcast “Out” position reporting, which will be required for aircraft in the U.S. by January, the MMR is capable of receiving and decoding signals from U.S. GPS satellites as well as Russia’s Glonass, China’s BeiDou and Europe’s Galileo constellations.

“The receiver is able to flex and grow and adapt because it has the processing throughput, the RF [radio-frequency] channelizations and antenna design, as well as the software-defined

Based on the Collins SSR-7620 Secure Server Router, the FOMAX on Airbus A320s and A330s collects performance and maintenance data from the aircraft and connects to data-link service-provider ground stations by satellite communications or VHF/HF radio, then by the ACARS ground network to airline operational centers. The router also connects by Wi-Fi and 3G/4G links when the aircraft is on the airport surface.

The company’s terminal and antenna for Certus, Iridium’s new high-speed L-band voice and data service for flight deck communications, are under development, with entry into service planned for the third quarter of 2021. In January, Collins announced it will supply Certus terminals as options on the 737 MAX and 777X, the first such terminals approved for forward-fit on the two airliners.

Iridium will deliver Certus from its new, second-generation Iridium Next constellation of low-Earth-orbit satellites, which was completed in January, nnectivity service to airlines and government and business aviation.

The company has opted to focus first on the Iridium product, Statler said. “We’ve led with our organic solution on Iridium Next first, because that’s an area we believe is going to get slightly higher market share than Inmarsat in the long run, due to the cost basis, the installation ease,” he said.

Collins is betting that HF radio, which airlines traditionally have used for long-range communications in oceanic airspace beyond the line-of-sight range of VHF radio, still has a long future, even with a plethora of new
satcom services coming online. The company is developing an HF Next (HFN) wideband, digital HF system at its Melbourne, Florida, facility that will support Future Air Navigation System oceanic communications requirements and provide “link diversity” in situations where satcom service is degraded or unavailable.

Sixteen Collins IMS-operated ground stations that support oceanic HF radio also will have to be updated to the new digital protocol.

“One of the criticalities not only today but when you look into the future, with reduced crew operations or autonomy, is dissimilar [communications] architectures, to make sure that you have backup if one [system] is interrupted for whatever reason,” said Statler. “Satcoms are a great business for us, but they are subject to atmospheric situations that could interrupt two satcoms” used for flight deck communications, Statler added. “In talking with our customers, we firmly believe there is going to be a need for a next-generation HF that will supplement a satcom. So what you will see on an aircraft will be an HF [radio] and their satcom of choice.”

Under a U.S. Air Force Research Laboratory project, Rockwell Collins in 2016 demonstrated the transfer from a Boeing C-17 of streaming video, real-time chat, file transfers and digital voice over a wideband HF channel, during a two-day flight between Dover AFB, Delaware, and Joint Base Lewis-McChord near Tacoma, Washington. The transport was fitted with a wideband HF receiver-exciter configured for airborne operation.

“It’s not an analog carrier wave of HF,” Peterson says of HFN. “We’re bonding channels and using a digital protocol for communications and data transmission. We’re digitizing your voice. This is not Amelia Earhart’s HF anymore.”

Collins is supplying its Pro Line Fusion integrated avionics system for the NASA/Lockheed Martin X-59 Quiet Supersonic Transport demonstrator, an aircraft designed to cruise at 55,000 ft. at Mach 1.2. The schedule calls for first flight in 2021.

The selection speaks to the flexibility and scalability of Pro Line Fusion, an open-architecture system Bombardier and Rockwell Collins announced in 2007 for the Global Express XRS and Global 5000 business jets. It now flies on platforms ranging from the Beechcraft King Air 350i turboprop to the Embraer KC-390 military transport.

Collins has embarked on a “Fusion Next” development focused on reduced pilot workload, enhanced sensor integration and eyes-up forward vision, said Statler. “Fusion really is an enablement suite of software. We deliver it in different hardware substantiations,” he said. “For some aircraft that need high reliability, triple redundancy, we may deliver it in a cabinet. For others, where we are able because of the form factor or the need of the market, we put it into a smart display—same software, but it’s put into the display processors.”
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The Practical Approach to Mars

By Robert Zubrin

During the week of April 18, the executive-branch-chartered Science and Technology Policy Institute (STPI) issued a review, which concluded that NASA’s plan to send humans to Mars by 2033 is not feasible.

While I would love to dispute this report, it actually understates the problem. If one accepts as necessary, as STPI was instructed to do, NASA’s “Exploration Campaign”—including the decades-in-development Space Launch System (SLS) and Orion capsule as well as its proposed lunar orbit Gateway station and Deep Space Transport interplanetary spaceship—there is no way NASA would be able to conduct even a Mars orbital mission, let alone a landing, by 2033, or 2063 for that matter. Indeed, it is questionable whether any agency so irrational as to embrace NASA’s current excessively complex Mars mission plan would ever be able to send humans to Mars at all.

Neither the Gateway nor Orion is useful for a Mars mission, as the Gateway is quite useless for anything (it is not needed to go to the Moon either), and Orion is seriously overweight compared to available alternatives such as SpaceX’s Dragon (26 tons versus 10 tons). The SLS, while offering some new capability, is overpriced compared to the already operational SpaceX Falcon Heavy and inferior in all metrics to the SpaceX Starship now under development.

But the truly unhinged part of the NASA Mars mission plan is the Deep Space Transport (DST). This system would use an immense solar-electric propulsion (EP) ion-drive system to travel from the Gateway to Mars and back, with one-way trip times of 300 days. This contrasts poorly with what chemical rockets can already do, as demonstrated by the Spirit, Opportunity and Insight missions, which reached Mars in 180 days starting from low Earth orbit (LEO). (If it had to start from LEO, the DST would take 600 days to reach Mars, thus the Gateway.) Furthermore, if a spacecraft were at the Gateway, it could get to Mars using chemical propulsion requiring less propellant than EP, despite EP’s much-touted higher exhaust velocity, because the trajectories the two systems would take are different. The amount of pushing an EP spacecraft needs to reach Mars from the Gateway is 10 times that required by a chemical rocket, a velocity change of 7 km/sec. (4.5 mi./sec.) versus 0.7 km/sec. But in addition, the EP spaceship needs to carry a huge 500-kW electrical power system to drive its engines, while the chemical-rocket-propelled vessel only needs 10 kW for life support. By implementing the futuristic DST, NASA is proposing to create a system that would take twice as long to transport astronauts to Mars, with twice the hardware and propellant mass, a much higher development cost and a much more complex mission plan than could be achieved using currently available off-the-shelf chemical rockets.

As if that weren’t enough, the DST uses xenon propellant, which is not obtainable from the Moon, as opposed to the oxygen/hydrogen propellant used by a chemical rocket, which conceivably could be. Using the unnecessary, slow, costly, complex and mission-bloating DST for the Mars missions negates any hope that the lunar base could ever play a useful role in support of human exploration of the red planet.

So the STPI is right. Using NASA’s current plan, we will not reach Mars in 2033 or any other time. But there is a clear alternative: the Mars Direct plan, or similar ones, which uses the upper stage of a heavy-lift rocket such as Falcon Heavy, Starship or SLS to throw necessary payloads on direct trajectories to Mars, with return methane/oxygen propellant produced from Martian water and CO₂ in advance of the crew’s arrival. No lunar orbit Gateways or advanced EP interplanetary spaceships are necessary. If NASA is serious about sending humans to Mars, it could readily do so by adopting such a practical approach.

Engineering is the art of making the impossible possible. Bureaucracy is the art of making the possible impossible. By choosing bureaucracy over engineering, NASA’s planners have transformed human Mars exploration from a mission into a vision.

The question is fundamentally this: Will NASA’s plan be purpose- or vendor-driven? A purpose-driven plan spends money to do things; a vendor-driven plan does things to spend money. If we allow NASA to remain in its vendor-driven mode, not only will we not reach Mars by 2033, it is questionable we will even return to the Moon by that time. But if we insist that our space program be purpose-driven, we can reach the Moon by 2024 and Mars before the end of the decade.

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The Practical Approach to Mars
Up a Future of Unlimited Possibilities
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