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CONTENTS DECEMBER 2020/JANUARY 2021

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Features

11 Intelligence

Edited by William Garvey, Jessica A. Salerno and Molly McMillin

Aerostructures Lands Bombardier Businesses

Overall, Air Accidents Declining

Charter Market Set for Growth

RUAG Sells Dornier Production to General Atomics

Dassault Falcon 6X Program on Track

AML Global Eclipse to Buy Assets of One Aviation Group

Fast Five With Walt Fricke, Founder, Veterans Airlift Command, St. Louis Park, Minnesota

Departments

DIGITAL EXTRAS

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Business & Commercial Aviation

BCA – Business & Commercial Aviation (ISSN 0191-4642) is published 10 times per year with combined issues in June/July and December/January by Informa Markets, a trading division of Informa PLC, 22701 W. 68th Terrace, Ste. 100, Shawnee, KS 66226-3583. Also the publisher of Aviation Daily, Aviation Week & Space Technology, The Weekly of Business Aviation and World Aerospace Database. Single copy: Current and back issues, $10.00 Domestic/Canada/Mexico. $15.00 International. Subscriptions (1 year, 10 issues): United States and Canada, $59.00; all other countries, $79.00. For single copies/back copies call Customer Service at (877) 368-6343 in the United States; +1 (913) 850-6929 for all other countries. Periodicals postage paid at Kansas City, MO and additional mailing offices. Registered for GST as GST #R126431964. Canada Post Publication Mail Agreement Number 40026880. USPS 503-450.

Printed in the U.S.A.

Postmaster: Send address corrections to BCA – Business & Commercial Aviation, 22701 W. 68th Terrace, Ste. 100, Shawnee, KS 66226-3583. (Present subscribers include label)

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President's Message

A Thanks and Welcome

Greg Hamilton
President, Aviation Week Network

"LEGENDARY" IS PROBABLY AN OVERUSED WORD, BUT IN THE case of our transitioning editorial leadership at *BCA,* it is apropos. Their service time combined, William "Bill" Garvey, Fred George and Jessica Salerno have devoted over 100 years — yes, a century — passionately and expertly serving the business aviation community's information needs. Along the way, they researched, composed, assigned, edited and delivered thousands of articles to help our industry fly more safely, productively . . . and enjoyably. And in the doing formed deep relationships and garnered accolades — too many to count.

When they announced their retirements, we were understandably concerned about how to carry forward the excellence of *BCA*'s content. Business aviation is a vital and demanding field. It's a big challenge to "get it right" for you — insightful, expert and analytical content is fundamental for success in your work, with timeliness and accuracy paramount to support decision making.

Fortunately, we have continued to invest through thick and thin this past decade in excellent editorial talent, along with innovative media platforms and delivery technology. With Bill Garvey's help and mentorship, we have put together a new digital product plan and the next-generation *BCA* team — all of whom have many years of experience covering the aviation industry and serving our audiences at the high standards you expect.

Leading the new team will be Lee Ann Shay, now executive editor of Business Aviation and *MRO.* She has been with the Aviation Week Network for 19 years, most recently as chief editor for *MRO.* She's not only an accomplished aviation editor and quite familiar with business aviation, but also is an innovative and collaborative force in delivering our multichannel content involving media, data, marketplaces and events.

Molly McMillin has been promoted to managing editor for Business Aviation, while continuing as editor-in-chief of the *Weekly of Business Aviation.* Molly knows the industry inside and out and is excited to step up to this broader role.

Bill Carey, Aviation Week's senior editor for avionics and air traffic management, has joined the team as senior editor for Business Aviation. Bill is one of the top technology editors in the aviation world and has spent a great deal of time during his career covering business aviation. His expert work even earned him an NBAA Gold Wing Award in 2017.

Lee Ann, Molly and Bill will be supported by a formidable global team of writers, editors and digital specialists across the Aviation Week Network, notably including Rebecca Badcock, who is the lead for digital content strategy for both *MRO* and Business Aviation.

On the business side, with Frank Craven pursuing new opportunities, Elizabeth Zlitni is stepping up into the Publisher role. She has been leading business development for our entire business aviation portfolio for several years and now takes on the general management role for *BCA,* as well.

For the past 10 weeks, the incumbent and new teams have been working closely together on the next generation *BCA*. They committed to retain its core values around how-to, safety, operational and aircraft-centric content, while transforming the digital delivery approaches to match content and audience needs.

Among the new features:

▶ A regular *BCA* Digest e-letter.

▶ Aircraft-centric landing pages curating our vast content stores for pilot reports, data, values and more.

▶ A new digital platform that delivers how-to and long-form content in multiple formats.

▶ Many more rich-media features: videos, webinars, podcasts, photography.

Lee Ann Shay

Molly McMillin

Bill Carey

Rebecca Badcock

▶ Business Aviation Marketplace, with thousands of products and services at your fingertips.

▶ And, of course, continued creation of such popular editorial series as Cause & Circumstance, Point of Law and 20/Twenty.

If you are a *BCA* subscriber, you will soon receive more details about a new digital membership incorporating all of the above into an integrated and useful content resource for you. On the advertising side, the possibilities for engaging the community are dramatically expanded, and I hope you will reach out to Elizabeth Zlitni just as soon as you read this letter!

Once again, our heartfelt congratulations to Bill, Fred and Jessica for stellar careers and service to your business aviation community. And welcome to Lee Ann and her team to carry forward the excellence from here. **BCA**


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CHOCKED, LOCKED and DONE

A final salute from BCA's retiring editors

FOR REASONS TOO FRUSTRATING TO DETAIL, THIS, MY LAST ISSUE of *BCA,* has been one of the worst to put together in recent memory. You would think after doing this job for what some might consider a ridiculous number of years, publishing an issue of *BCA* would be "old hat," maybe even boring.

Well, trust me, being executive editor of this magazine has been everything but dull. And now as I look back, I feel a wonderful sense of accomplishment and am very proud of the good work our team has done for an incredible industry. Will I miss it? You bet.

It's been a joy to watch life-long industry friends grow and prosper, and to be a part of an industry where the majesty of the airplane defines all we do. To all of my colleagues, know that you are cherished and will be held in my heart till the sun goes down. Thanks for the stories and fabulous memories. **— Jessica A. Salerno**

YOU AND I HAVE TRAVELLED A WONDERFUL PATH TOGETHER. WE graduated from recips to turboprops to turbojets to turbofans. We learned straight-wing, low-altitude aerodynamics then swept-wing high-altitude technologies. We started with ADF, then VOR and ILS and went on to GPS, R-Nav, spinning metal INS and then spinning light.

Our air data instruments involved tubes, bellows and clockwork mechanisms and then, overnight, data went solid-state and our displays graduated to eight-segment light schemes to CRTs, LEDs and high-resolution flat panels.

Meantime, our instruments began exchanging information. Microcomputers and data buses monitored and protected the engines, airframe systems and avionics. Finally, the exchange evolved into a neural network.

An airplane once comprised airframe, engine(s) and avionics. Today these components are one, inseparable, a flying computer.

And always, we've explored the man-machine interface with all its sometimes-stumbling progress.

I have been truly blessed to have made this journey with you our readers. We have learned much together on this 52-year flight. Stay safe. **— Dick Aarons**

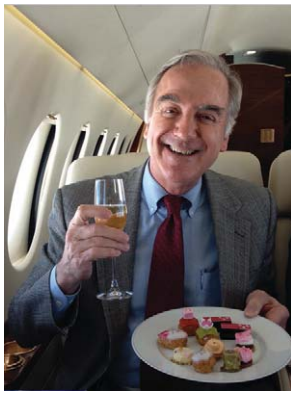
A CONFESSION: I'M A PACK RAT, HAVING SAVED HUNDREDS OF business cards during my half century of flying. So, I recently started sifting through them, intending to toss most. Yet, the more I perused, the more I was reminded why aviation has been so rewarding as a career.

Astronauts, engineers and test pilots, entrepreneurs, inventors and tycoons, war heroes and air racers, all taking bold risks, pushing back frontiers, raising expectations. We met at airports, onboard aircraft carriers, in offices and laboratories, at conventions, expos and company headquarters.

So many of those people made possible all my great memories of flying 230+ makes, models and variants of aircraft, ranging from the Fuji Blimp to the Mach 2 Rafale, from the J-3 Cub, the original ultralight, to the 300-ton A350.

So, I can't toss those business cards. They remind me that it's not about hardware. Rather, it's all about the remarkable people who made it possible. Thank you all. **— Fred George**

AS *BCA*'S NEW GUY — I JOINED ONLY 20 YEARS AGO — IT'S FITTING that I'm last to offer sincere thanks to my extraordinary colleagues including Frank Craven, our exiting publisher, legendary predecessors and to you, business aviation's professionals.



All have provided support, inspiration, insight and, occasionally, deserved criticism.

Our purpose has always been to deliver editorial that helps you do your jobs more efficiently, safely and in ways that make you even more valuable to your organizations. In the process, I've reported from five continents (I'll get Down Under yet) took controls of everything from a Starduster and Commanders to TBMs and Citations, and had one-on-ones with presidents, visionaries and pioneers.

Decades ago, when signing off my first flight check, champion aerobat Mary Gaffaney urged me to become an aviation professional. Earlier this year, in sharing honors with Capt. Jim Lovell and Sergei Sikorsky, it occurred to me that, fortunately, I'd taken her advice. And I'm indebted to all who have helped make that decision so rewarding. **— William Garvey**

Readers' Feedback

Aireon Serves

First, **"Aireon in Service" (November 2020)** was a wonderful article. We appreciate your thoroughness. It was really a fantastic piece!

On another note, Aireon has some exciting news that we may have alluded to in some of the interviews. We have just announced three new commercial products for the ATM industry:

AireonFLOW provides ANSPs with a high-fidelity, low-latency source of aircraft position data beyond FIR boundaries and AoR without the need to sign data-sharing agreements with neighboring countries.

AireonSTREAM provides global, gate-to-gate, surface-to-space, high-fidelity ATS surveillance data, combined with flight and airspace contextual information including infrastructure, weather, avionics, aircraft registry and schedule data to enhance tracking, situational awareness and analytical tools.

AireonINSIGHTS provides aircraft tracking events and alerts for flights, including airport and airspace events, ongoing flight data, safety events and alerts to provide key performance indicators related to a flight's operational safety and efficiency.

Through advanced data fusion mechanisms, we will now integrate a robust set of aviation sources and derived metrics into our data through these new product offerings. We are combining contextual information such as airspace infrastructure, weather, avionics, aircraft registration and schedule data, to enhance asset tracking, aircraft situational awareness and decision support analytical tools for the whole industry.

Jessie Hillenbrand
Aireon
McLean, Virginia

First and foremost, I wanted to say **"Aireon in Service" (November 2020)** is one of the best I've read in explaining the benefits and why it's an important new capability. (In fact, our CEO, Matt Desch, sent me a note saying just about the same thing).

I had one minor clarification for you regarding the launch campaign of the new satellites. Originally, we had intended to send two satellites up on a Dnepr rocket, but for a variety of reasons, that plan didn't work out, so all of our launches took place using SpaceX Falcon 9 rockets. We did seven launches of 10 satellites and one launch of five (which was a rideshare with two NASA satellites), for a total of eight launches and 75 rockets.

Jordan Hassin
Iridium Communications, Inc.
McLean, Virginia

Valued Over the Years

I just wanted to let you know how much I've valued *BCA* over the years, and I've looked forward to its arrival every month. There has always been a wealth of both technical information combined with human perspectives in articles that have been useful for my work as a Flight Surgeon interacting with Aircrew in the address of Aerospace Medical issues. As

a pilot, I find the reading quite applicable and interesting.

Many would find it daunting to know of the extreme temperatures we have during the Winters at 4 Wing Cold Lake; the fact that all Aircrew, Technical, and Maintenance Personnel can provide the high level of commitment to NATO, NORAD, and Sovereignty Operations in such conditions is awesome. Our assets fly in close cooperation with the U.S. Air Force covering Alaska and Northern Canada, a testament to a unique inter-operability in an often harsh environment.

Dr. James B Hanley MD, FRCPC
Flight Surgeon
Alberta, Canada

Editors' note: Thank you for your comments, years of loyal readership and protection of aviators in an unforgiving place, Dr. Hanley. As noted in this issue, we're "Chocked, Locked and Done," but *BCA* and its editorial mission continue on, albeit with a new team and in another medium.

Update to the August Operations Planning Guide

There was a math error for the Embraer Legacy 600.

The correct Direct Cost numbers are: 300 nm, $1,617; 600 nm, $2,814 and 1,000 nm, $4,416.

The error was pointed out to us by Embraer's Ricardo Carvalhal, Sales Engineering Director.

Icing Lessons

I enjoyed **"The Anti- Anti-Ice Protection" (October 2020)** by Dr. Pat Veillette.

In 1981, I learned a valuable lesson about bringing a warm aircraft, specifically a Sikorsky S-76, outside of a hangar during a snowstorm. Large, wet snowflakes were melting on the helicopter's surfaces just minutes before the passenger (the CEO) showed up and by the time he pulled into his parking spot by the helipad, the helicopter and rotorblades were covered with thousands of coin sized ice caplets and I had to cancel his flight into NYC.

We had to bring the helicopter back into the hangar, allow the ice to melt and be dried off, then open the hangar and allow the aircraft to assume a very cold temperature before taking it back outside and fly into the city, albeit two hours behind his scheduled meeting.

Fortunately, the CEO was a rated helicopter pilot and he learned the same lesson that I learned that day. The problem never happened again, but our mechanics had to work in a very cold hangar over the next nine years that I worked there if it was snowing and I had "pop-up" flights.

From then on, if I knew the helicopter would be needed and it was snowing outside, I would go to the hangar early, get the doors open and get the helicopter nice and cold before they reported for work, then take it out when it was needed.

Keith Fritz
Jordan River Aviation
South Jordan, Utah

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INTELLIGENCE

EDITED BY **WILLIAM GARVEY, JESSICA A. SALERNO AND MOLLY MCMILLIN**
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NEWS / ANALYSIS / TRENDS / ISSUES

AEROSTRUCTURES GIANT SPIRIT AEROSYSTEMS struck a 45% cash discount with Bombardier for the latter's Short Brothers capacity in Northern Ireland, as well as Bombardier Aerospace North Africa and most of a Texas MRO site. Those businesses are based in Belfast, Casablanca and Dallas, respectively. The companies were expected to close the deal on Oct. 30. The Wichita, Kansas company announced the new terms Oct. 26, just five days ahead of the deadline for closing the nearly year-old acquisition agreement with the Canadian airframer. The amendment cut the net proceeds purchase price payable to Bombardier to $275 million from $500 million. At signing on Oct. 31, 2019, Spirit said the deal had a then-total enterprise valuation of $1.09 billion. The new terms cut that to $865 million, down about 20%.The move makes Spirit one of Bombardier's largest suppliers, increases work content for Airbus, and also diversifies Spirit's revenue streams with more aftermarket sales. Spirit has been working for years to diversify away from Boeing commercial aerostructures work, which accounts for most of its annual revenue. Both companies were motivated to close the deal. With the price reduction, Spirit saves roughly $355 million of near-term liquidity, according to Jefferies. Bombardier, meanwhile, receives badly needed funds to continue its own transformation as it focuses on being a business jet provider only. Both companies have seen their stock and credit ratings sink this year as cash concerns skyrocketed in the wake of COVID-19's devastating affects to the commercial aviation sector.

DASSAULT AVIATION WAS SCHEDULED TO DEBUT ITS NEW ULTRA-WIDE FALCON 6X business jet Dec. 8, rolling it out of its production facility in Bordeaux-Merignac, France. Test flights are scheduled to begin in early 2021. Testing on the first aircraft is ongoing and the second and third aircraft are nearing final assembly, the company reported. Electric, hydraulic and fuel system tests were completed prior to rollout and tests of its digital flight control system, damage tolerance and fatigue tests initiated. Aircraft No. 3 will be outfitted with a full interior to evaluate systems functionality, acoustics, airflow, comfort and other factors, the company said. "Development of the 6X, including its Pratt & Whitney Canada PW812D engine is right on schedule," Dassault said. " Certification and first delivery of the 5,500 nm, three-section aircraft are expected in 2022.

JET IT, A GREENSBORO, NORTH CAROLINA-BASED FRACTIONAL OPERATOR, has placed an order for 10 HondaJet Elites with delivery to be completed over the next year. The first was delivered in September. The order, combined with the seven HondaJets already in Jet It's North American fleet, will make the largest operator of the type on the continent. An equipped HondaJet Elite has a list price of $5.28 million, according to Aviation Week's Business & Commercial Aviation magazine. A demonstration pilot at Gulfstream before moving to Honda Aircraft as a sales manager, CEO Glenn Gonzales said when creating Jet It in 2018, he and co-founder Vishal Hiremath took a cue from Southwest and jetBlue airlines in settling on a single model. The company since has grown to more than 50 employees with plans to add additional staff. Under Jet It's business model, clients have the aircraft for an entire day and may fly as many hours as they can squeeze in a normal crew duty day. Clients may buy from one-tenth to half of an aircraft. The company launched JetClub in September to bring its services to Europe and Asia.

General Atomics Gets Dornier Production

Switzerland's RUAG International is selling production of the 19-seat Dornier 228 twin-turboprop regional aircraft to General Atomics' European business which is also taking over RUAG's Oberpfaffenhofen, Germany-based maintenance, repair and overhaul operations for business aircraft and military helicopters.

The two businesses employ around 450 people. RUAG International's Oberpfaffenhofen-based aerostructures business is unaffected by the deal.

RUAG acquired the rights to the Dornier 228 after Fairchild Dornier declared bankruptcy in 2002. RUAG subsequently certified a new version of the aircraft, the Dornier 228NG equipped with a glass cockpit and Honeywell TPE331-10 engines driving a five-bladed propeller in 2010.

The decision to sell Dornier 228 production and the MRO business is part of the Swiss government's unbundling of the state-owned company into two separate operating units, one, MRO Switzerland focused on supporting the Swiss armed forces, the other RUAG International focused on technology.

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ANOTHER COVID CABIN STUDY The U.S. Transportation Command is responsible for the mobility of American forces, including the transport of troops on aircraft, and it wanted scientific answers regarding the infection risk posed by aircraft cabins. Accordingly, it formed a **multi-disciplinary research collaboration** that included the Pentagon's Defense Advanced Research Project Agency and Air Mobility Command, and the National Strategic Research Institute at the University of Nebraska, Zeteo Tech, L2 Defense, S3i, Boeing and United Airlines to better understand the risk of COVID infection to aircraft cabin occupants created by the respiratory particles emitted by an infected passenger.Small particles generated during breathing and typical speech average only 1 micron in diameter and are too small to see without specialized equipment. These particles can carry a variety of respiratory pathogens including influenza. There is concern that these can be potent transporters of respiratory disease because they may penetrate farther into the respiratory tract. There is also concern because speech can release two to 10 times as many particles as a single cough.

A specially equipped mannequin that mimics human breathing was placed at varying seats throughout the cabins of a United Boeing 767 and 777 where advanced instrumentation measured the dispersion of the mannequin's tiny particles to neighboring seats and rows. The project utilized tiny fluorescent particles (between 1 and 3 microns) tracked by real-time optical sensors, as well as DNA-tagged trace particles to track their spread. Over 300 aerosol releases were performed in eight days, which included inflight tests at altitude (35,000 ft.).

This was the largest aircraft aerosol experimental testing to date. Potentially one of the most important findings of this project was the importance of airflow, air exchange rates and filtering to minimize the spread of airborne pathogens. The advanced instrumentation used by this study observed rapid dilution, mixing and purging of the particles breathed or coughed by the mannequin due to the combination of high air exchange rates, downward ventilation design and HEPA-filtered recirculation. The 767 and 777 both removed particulate 15 times faster than a home and five to six times faster than the recommended design specifications for patient isolation rooms.

The results of this study concluded that the exposure risk from these tiny respiratory particles is minimal even during long-duration flights. The highest risk occurred to passengers in the row of the infected patient. Rows in front and behind the infected patient had the next highest risk on average. The study also found that contamination of surfaces from the particles was minimal. Overhead gasper fan settings did not make a significant impact on aerosol risk.

The report, titled **"TRANSCOM/AMC Commercial Aircraft Cabin Aerosol Dispersion Tests,"** is pending submission to a scientific journal for peer review and publication, but the sponsor released it in light of its timeliness to the public. Earlier studies cited in **"Flying Petri Dish" (BCA, November 2020)** came from peer-reviewed scientific journals.

It is important to compare and contrast the results from this project with other studies to put each into their proper context. This test focused on the tiniest droplets expelled from a person during breathing or coughing. However, larger droplets (50-100+ microns), also generated when talking, coughing or sneezing, can contaminate the surfaces in lavatories or other common areas. These alternative routes of exposure are more challenging to predict because of the uncertainty in passenger behavior.

The test mannequin remained facing forward, whereas real passengers turn their heads for conversation, and remove their masks for eating and drinking. This will change the risk and directionality in the closest seats to the infected passenger, especially large droplets.

The project included trials using standard, pleated three-ply surgical masks and determined, **"The application of a mask provided significant protection against micron diameter droplets released during the cough simulations and reductions greater than 90% were measured."**

This is a positive example of multi-disciplinary groups from industry, academia, government and the military working together on difficult issues. Tough problems such as these require substantial resources and advanced instrumentation to further our state of knowledge. We will keep track of this and similar studies as they complete the peer-review process.

– Patrick Veillette, Ph.D

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THE AIRCRAFT OWNERS AND PILOTS ASSOCIATION (AOPA) is working with

Save Dillingham Airfield Group, an organization pushing to keep Dillingham Airfield on the north shore of Oahu in Hawaii open. The airport is scheduled to close on June 30, 2021. Before the COVID-19 pandemic, the airport supported 130 jobs and injected $12 million into the economy, in addition to providing glider rides, skydiving, and flying lessons. The aviation industry has rallied around the airport since the state revealed plans to close early and end its airport lease from the U.S. Army that would have otherwise expired in 2025.

A U.S. DISTRICT COURT JUDGE HAS DISMISSED a claim by business aviation leaders who sought to overturn an agreement with the FAA that allows for the closure of Santa Monica Municipal Airport (KSMO) near Los Angeles, California. The case was filed by the National Business Aviation Association (NBAA) and local airport advocates who sought judicial review of the surprise settlement between the FAA and the City of Santa Monica, the facility's owner. The 2017 agreement allows the city to shorten the airport's sole runway from 4,973 ft. to 3,500 ft. to limit jet flights, a move which has been completed. **It also permits closure of the airport after Dec. 31, 2028, which city officials say they plan to do.** NBAA contended that the FAA exceeded its authority in the settlement and challenged the agreement in the U.S. Court of Appeals for the District of Columbia. That case was dismissed on procedural grounds in June 2018. NBAA and other groups then pursued another legal path to preserve the airport and filed the most recent complaint in July 2018. On Oct. 9, the judge for the U.S. District Court for the District of Columbia dismissed the case on procedural and jurisdictional grounds. The ruling was "disappointing, in that it shielded FAA action from judicial review," said Alex Gertsen, NBAA director of airports and ground infrastructure. **The airport is important in the nation's air transportation system. It also creates jobs and provides a "significant" economic impact, Gertsen said.** It is also key in aeromedical transport and for disaster relief efforts when necessary. NBAA, SMAA and other groups continue to support a pending case before the California Supreme Court that could shift the balance in favor of preserving the airport over the current anti-airport stance of the Santa Monica City Council, Gertsen says.

VANDERBILT LIFEFLIGHT WAS RECENTLY NAMED THE AIR MEDICAL PROGRAM OF THE YEAR by the Association of Air Medical Services (AAMS). The award, sponsored by Airbus Helicopters, recognizes an air medical program that has demonstrated a superior level of patient care, management prowess and quality leadership through innovative approaches, customer service, safety consciousness, community service and commitment to the medical transport community. The air unit is operated by Vanderbilt University Medical Center, Nashville, Tennessee in partnership with Air Methods. While this marks the first time the program has received the 23-year-old honor, in 2005, LifeFlight Executive Director Jeanne Yeatman received the AAMS Excellence in Transport Leadership Award and in 2003, former flight nurse Kevin High received the Crew Member of the Year award. "Vanderbilt LifeFlight has been a world-class leader in the area of critical care transport since 1984 and has set the pace in providing innovative air medical transport services," said Yeatman, MBA, RN, now interim chief nursing officer at Vanderbilt Wilson County Hospital and associate chief nursing officer, as well as LifeFlight's executive director. "On behalf of our more than 300 employees, I am honored and humbled to accept the 2020 AAMS Program of the Year award. The award is a reflection of our commitment to our hard-working employees, their safety and patient care."

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INTELLIGENCE

THE NORTH AMERICAN CHARTER JET services market is projected to record a compound annual growth rate of 3% per year from 2020-2025, according to **ResearchAndMarkets.com**. The demand increase reflects a hike in per capita income levels of the middle class in North America, allowing them to opt for charter for tour and travel, the report says. Growth is encouraging charter service providers to expand their fleets, the report says. Emerging aviation emission norms have bolstered demand for new-generation aircraft and a presence of a large high-net-worth clientele in North America has positively affected demand, it says.

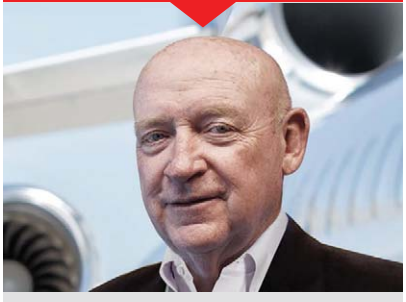
PYKA, A CALIFORNIA STARTUP, BELIEVES CAN ACCELERATE fielding of two of the hottest technologies in aviation: autonomy and electric propulsion. The four-year-old company is developing an **unmanned, battery-powered agplane for missions involving short flights at low altitude over large farms and well away from populated areas.** Company CEO and co-founder Michael Norica noted the aircraft, called the Pelican, was granted a special airworthiness certificate in early October clearing it for non-commercial testing and demonstrations at selected farms in California and Nevada. Powered by three 20-kW electric motors driving propellers on the wing and tail, the 38-ft.-span sprayplane can carry a 625-lb. payload and take off and land within 150 ft. If certified, the Pelican will be the largest unmanned aerial vehicle in the civilian fleet. The big drone can spray up to 135 acres/hour at 2 gal./acre, including refilling the tank and swapping the batteries. Each flight lasts about 10 min. and batteries are swapped after three flights and recharged on the ground. Pyka has built three Pelicans and plans to produce one every two months. The startup will operate the aircraft itself initially, but plans to market it later.

ITALY'S TECNAM HAS PARTNERED WITH ROLLS-ROYCE to develop the 9-passnger P-Volt, an all-electric version of the planemaker's P2012 Traveller regional aircraft. The Capua-based airframer said the program is supported by letters of intent from unspecified "North American and European airlines." No details of the performance of the aircraft or timescale for the program were initially released. Tecam said the aircraft "will be the first commercial 9-passenger, cargo, medical evacuation and special mission aircraft to be electrified directly by the manufacturer." **The P-Volt will be proposed to the European Commission as part of the planned Clean Aviation follow-on to the Clean Sky research program,** and the company said it is "committed to see a certified product flying with passengers on scheduled commercial flights within the second half of 2020s." Described as "short and medium range," the P-Volt has two wing-mounted Rolls electric motors replacing the P2012's 375-hp Lycoming TEO-540-C1A piston engines. A pannier installed under the fuselage likely houses a battery pack. "All-electric motors, avionics, heating, air conditioning and state-of-the-art de-ice/anti-ice systems will provide fully sustainable and pollution-free transportation," according to a Tecnam statement. The first operator of the P2012 Traveller, Cape Air, the Massachusetts-based regional, already has an agreement with Israeli startup Eviation to participate in development of its 9-passenger Alice all-electric regional aircraft. The Alice prototype is planned to fly early in 2021. Dan Wolfe, Cape Air's founder and CEO, has previously spoken of his desire to operate a zero-emissions aircraft powered by renewable electricity generated by wind farms off the coast of Massachusetts. Tecnam, meanwhile, is already working with Rolls-Royce on the European-funded H3PS to convert the company's four-seat P2010 into a parallel hybrid-electric powertrain prototype. The standard 215-hp Lycoming IO-390-C3B6 engine has been replaced by a smaller, 141-hp Rotax 915iS, which is augmented by a battery-powered 30-kW motor/generator. This reduces fuel consumption by 10-15%.

Garmin Wins Grand Laureate

Garmin International and its Autoland technology, a virtual copilot that can control and land an aircraft automatically, was named the recipient of Aviation Week Network's 2020 Grand Laureate for business aviation for its advancement in safety. Grand Laureate winners for Aviation Week's 63rd annual Laureate Awards were announced during a virtual event Oct. 19.

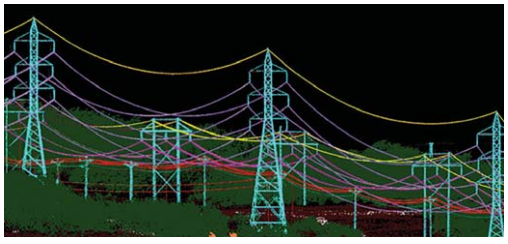
Boisture Joins Spike Aerospace



Heeeee's back. Well, he never left, really. But Bill Boisture, the former president and/or CEO of Hawker Beechcraft, Gulfstream, NetJets and Butler Aviation, among other executive roles in business aviation, has now joined the executive team of Spike Aerospace. Spike is developing an 18-passenger supersonic jet for private, corporate and airline operations and Boisture says he will help the company develop its strategy and build relationships. Today the former U.S. Air Force fighter pilot is an operating partner at AeroEquity Industrial and sits on the boards of several AE Industrial portfolio companies.

THE AOPA AIR SAFETY INSTITUTE'S recently released editions of the Joseph T. Nall Report note a continued decrease in overall accident rates for noncommercial and commercial fixed-wing operations, noncommercial and commercial helicopter operations, and sport/experimental operations. The overall accident rate in 2017 was 4.81 per 100,000 flight hours and 4.56 in 2018. The fatal accident rate also decreased to 0.76 per 100,000 hours in 2017 and 0.74 in 2018, based on available data. The data show a decrease in total accidents in 2017 from 2016, but 2018 saw an increase in total accidents. However, the overall and fatal accident rates continued downward trends.

TRANSPORT CANADA HAS GRANTED GEOMATICS COMPANY MVT Geo-solutions permission to fly drones beyond visual line of sight (BVLOS) of an operator to perform powerline inspections in Alma, Quebec. Award of the special flight operations certificate (SFOC) is based on the drone's use of the Iris Automation detect-and-avoid (DAA) system and flights in low-level airspace that is typically inaccessible to manned aircraft because of the close proximity of buildings or infrastructure. Iris Automation announced the regulatory approval on Oct. 14. The San Francisco-based DAA system developer said it is part of a team with MVT Geo-solutions and the Alma Unmanned Aircraft Systems Center of Excellence that secured the SFOC. The certificate is for commercial operations in uncontrolled airspace and does not require the operators to use visual observers or ground-based radar to keep track of the drone. Jon Damush, Iris Automation CEO said, "Drones offer tremendous promise in terms of safety and economics as compared to piloted aviation alternatives, but we must integrate them into the airspace safely." Transport Canada started approving routine BVLOS operations in July 2019 "in circumstances that pose a lower risk to people on the ground and [to] other airspace users." By October it had issued 49 SFOCs for lower-risk BVLOS operations. On Oct. 5, meanwhile, the North Carolina Department of Transportation (NCDOT) announced that it has obtained an FAA waiver to conduct bridge inspections using drones BVLOS. Drone manufacturer Skydio assisted NCDOT in developing the waiver application.



AML GLOBAL ECLIPSE, A U.S. FIRM, REACHED AN AGREEMENT with One Aviation Corp. in October to buy the assets of Eclipse Aerospace and the Eclipse Aircraft project for a proposed $5.25 million. One Aviation, formed when Eclipse merged with Kestrel Aircraft in 2015, filed for bankruptcy protection two years earlier. A court hearing to approve the sale was set for Nov. 6. AML Global Eclipse is backed by Christopher Harborne, a British businessman, technology investor and pilot. He owns AML Global and is also CEO of Sherriff Global Group in Hong Kong In announcing the agreement, Harborne said the alternative to the acquisition would have been One Aviation's liquidation, "which would have been catastrophic for the project, the workforce and the existing fleet." **It is not yet clear what the future prospects for the Eclipse project may be, he said.** But if the agreement is approved by the bankruptcy court, "we look forward to working actively with all relevant parties to find a viable way forward." He added that he welcomed contact with any and all furloughed or former employees, suppliers, service providers and Eclipse owners to discuss "how we can build a successful future together."

THE FAA HAS ISSUED AN AIRWORTHINESS DIRECTIVE REQUIRING repetitive inspections of 14,653 U.S. registered single-engine Cessna 172, 182, 206, 207 and 210

models to check for cracks in the strut attach fittings at the forward cabin doorpost. In the AD, the FAA warned that loading conditions outside of flight, such as ground loads, handling loads and tie-down loads, may cause cracking at the site and that the condition, if not addressed, could cause "failure of the wing in operation." The FAA estimates the cost of compliance of $212.50 to inspect the lower area of the forward cabin doorposts and to comply with the reporting requirement. It also estimates the cost to install a service kit, if required, at $6,175 to $10,550, depending upon the kit.

THE CEO OF ITALY'S LEONARDO HAS BEEN SENTENCED TO SIX years in prison for crimes committed in a previous role. Alessandro Profumo was recently found guilty by a Milan court of false accounting and stock manipulation in charges dating back to when he was chairman of Banca Monte dei Paschi di Siena (MPS), where he served from 2012 to 2015. Profumo, who became head of Leonardo in 2017, was also fined (Euro) 2.5 million ($2.9 million) and barred from running a company for two years. The process is far from final, however. Profumo's lawyers have said they will challenge the verdict in the appeal courts. This process can take several years and the sentence will only be effective if this process fails. In a statement, Leonardo said it was standing by the chief executive, expressing its "full confidence" in Profumo and calling for his position at the aerospace company to continue, adding that the "conditions do not exist for the cessation of his role."

A CESSNA 337 SKYMASTER WHOSE FORWARD GAS engine was swapped out with an electric motor, completed a 297-nm flight from Camarillo to Hayward, California in October using its prototype hybrid-electric-powered Electric EEL. The flight took 2 hr., 32 min., averaging

135 mph. Ampaire, the startup behind the demonstration, asserts the transit was "the longest flight to date for any commercially relevant aircraft employing electric propulsion." The aircraft, Ampaire's second prototype, is planned to be test-flown on the island of Maui, on routes operated by Hawaiian regional carrier Mokulele Airlines. The Ampaire Skymaster's forward electric motor is powered by batteries housed in the cargo pod under the fuselage. The rear-mounted internal-combustion engine is retained.

ALTHOUGH FAA'S YEARS-LONG SEARCH FOR A LEAD-FREE replacement to 100LL avgas has had no success as yet, Avfuel Chairman Craig Sincock believes one will be found, and that the effort needs the full backing of the aviation community. He notes that avgas "remains the only commercially available fuel to still contain lead" and that there's a "growing environmental advocacy" to eliminate the hazardous compound. The Environmental Protection Agency along with the U.S. Congress and FAA support the clean fuel concept with the latter creating the Piston Aviation Fuels Initiative (PAFI), a government-industry collaboration to set standards for and evaluate alternative fuels. **That effort, now in its sixth year, has tested a number of lead-free fuels but each one has failed in some critical way as a drop-in replacement.** Still, Sincock says that with PAFI's renewed efforts together with alternatives being developed outside by units such as Avfuel Technology Initiatives Corp., he anticipates "reasonable progress toward a solution in 2021 and 2022." However, if and when an acceptable high-octane, unleaded solution is found, he says it's likely to take "a few years" to fully address the challenges of producing and distributing the throughout the supply chain.

Bombardier to Open Melbourne, Australia Service Center

Bombardier Aviation is developing a new service center at Essendon Fields Airport in Melbourne, Australia. The new Bombardier-owned, 50,000-sq.-ft. service center will employ 50 people, including more than 40 technicians, and feature a 4,000-sq.-ft. parts depot. Construction is scheduled to begin in 2020, with an opening set in 2022.

TRAXXALL's New Maintenance Tracking System

TRAXXALL has launched TRAXXALL 360, a cloud-based maintenance tracking system that streamlines workflows with an intuitive user interface. The new management system generates actionable business intelligence, minimizes aircraft downtimes, and contributes to operational efficiencies, the company says. It is used by business aircraft operators in 57 countries including Jet Linx, North America's second-largest operator of business jets.

INTERVIEW BY **WILLIAM GARVEY**

Walt Fricke
Founder, Air Boss
Veterans Airlift Command (VAC)
St. Louis Park, Minnesota
(Walt.Fricke@veteransairlift.org)

Severely wounded in combat when his Huey gunship's rocket exploded during combat in Vietnam, Fricke spent months in hospitals stateside — lonely, worried, in pain and a long way from family. He never forgot that experience. After a very successful career in finance, in 2006 he invested his time, thought and money to ease the worry and loneliness of other wounded veterans by creating the VAC, a nationwide system of thousands of volunteer pilots and aircraft dedicated to transporting wounded veterans and their families wherever they need to go, for free.

TAP HERE in the digital edition of ***BCA*** to hear more from this Interview or go to **AviationWeek.com/BCA-Fast-Five**

Questions for Walt Fricke

1. What was the VAC's genesis?

Fricke: When I retired, I questioned what I would do with the rest of my life. I had my own airplane and came up with an idea: Since wounded vets can have trouble traveling commercially, I would fly them wherever they wanted. In my career, I'd worked with the Defense Department on mortgages for veterans, so the Pentagon knew me. Then one day I got a call about a young Marine from Melbourne, Florida, who had traveled to Camp Lejeune, just 500 mi. north, to receive his Purple Heart. But he needed a wheelchair and crutches to get around and the trip required him to board and exit four commercial flights. He reached Lejeune 13 and a half hours later, completely exhausted. His father called the DoD, asking for help and then they called me. I contacted eight pilots I knew in Florida and South Georgia and five of them immediately volunteered to fly that weary Marine home. The flight took less than 2 hr. At that point, I was sure my idea was sound and way bigger than just me.

2. How much bigger?

Fricke: The VAC has flown more than 18,000 passengers and has registered over 2,600 pilots and aircraft into the program. Many of the missions have involved getting the vets to medical treatment, but we'll fly for other compassionate reasons and these have ranged from taking families on vacations, to unit reunions and other events. Trips can be quite emotional, and our volunteers get as much satisfaction out of them as do our passengers.

3. Are all pilots and all aircraft eligible to participate?

Fricke: The volunteer pilots have to be instrument proficient since all flights file IFR. Some small general aviation aircraft have participated, but roughly 80% of our missions involve business jets, turboprops or multiengine piston aircraft. And with certain exceptions, most of our veterans are ambulatory, though flying them could involve multiple passengers and carrying support equipment like wheelchairs.

4. Has the pandemic impacted the VAC?

Fricke: Yes. Missions requests were way down in the spring, but now with the airline service cutbacks, medical trips that had been delayed are back at an accelerated rate to near normal. Unfortunately, we had to cancel our big fundraising event this year, which is tough because we only have one. So, it's been a challenging year financially. Thankfully, we have had strong support from sponsors over the years, including Bruce Rose of the Carrington Foundation, Signature Flight Support, Textron Cessna, Wilson Aviation and, most recently, the Car Donation Foundation, which inspired the VAC to solicit the gift of any planes that owners want to retire.

5. Even though it's a volunteer organization, you have overhead, yes?

Fricke: We have four full-time employees to recruit pilots and coordinate flights, all of whom work at home. No bricks and mortar and very limited fixed costs. In the early years, I funded it all, but then contributions started coming in. More recently we have set up the VAC Perpetual Fund to cover all overhead permanently. Legacy Members of the fund will be those who donate aircraft or other assets valued at $10,000 or greater to this endowment. Experience tells us that once the founder exits organizations like the VAC, they begin to shift focus from the clients served to the donors and that focus eventually takes precedence over the mission for which the organization was created. I don't want that to happen. Our target is to raise $15 million for the fund — and we're two-thirds of the way there. Once that is achieved, even with me gone, wounded vets can be assured the VAC will be here to fly them forever. **BCA**

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Technophobia

Not an irrational fear; **it's a survival mechanism**

BY **JAMES ALBRIGHT** james@code7700.com

technophobe
['tekne fob']
NOUN
A person who fears, dislikes or avoids new technology.

Yes, I am a technophobe in the strictest sense of the definition, with an emphasis on the word "new." I don't trust anything that hasn't been proven.

Of course, it wasn't always that way. I embraced computers early on. As an engineering student in 1974, my interaction with computers was via punch cards, and you counted lines of codes by the thickness of your card deck.

In 1983, I wrote a program for my U.S. Air Force Boeing 707 squadron to automate the chore of computing navigation and fuel logs and I thought that was great until we discovered an error in one of my lines of code. My mistake impacted all four of our squadron's airplanes. In 2004, another software error in an air traffic control computer impacted 800 airplanes.

As aircraft become more and more dependent on computers, the result of a "software glitch" becomes harder and harder to predict. If an airplane is completely airworthy when flying on one side of a line of longitude, how could an imaginary line in space prevent it from flying according to specs on the other? Or how about another airplane whose electrical system now has a calendar-based limitation? Examining a few examples where these glitches were thought to be unpredictable can help us better prepare ourselves for what we cannot possibly foresee.

Going Digital for the First Time

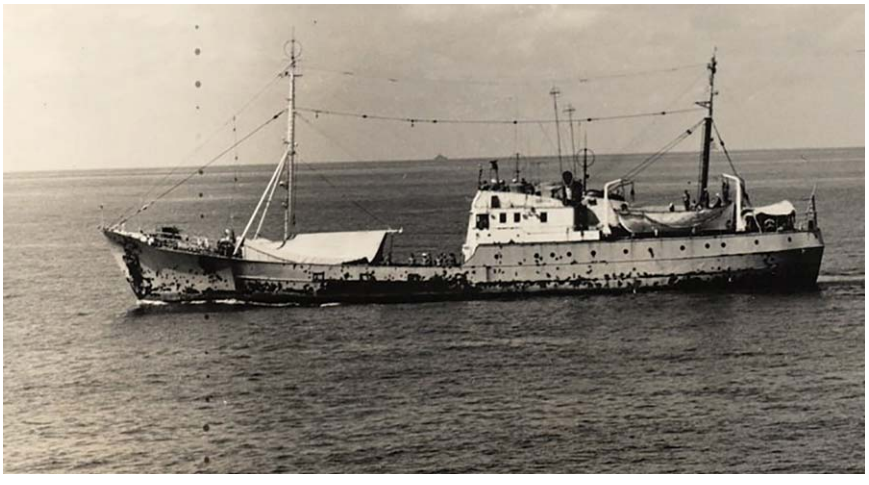
In 1982, I was a copilot flying U.S. Air Force Boeing 707s (EC-135Js) with only one thing in the cockpit that could be remotely called a computer, and that was the flight director. A mission always started the day before with the navigator pulling out a paper chart, a plotter and dividers. After a few hours he would have a navigation log. Then I would take that log and a book of charts and add fuel computations. I would hand all of that to the aircraft commander, who would pick up the phone and order a fuel load for the next day's mission. This ritual took about 4 hr. All that changed the following year when the squadron got its first desktop computer, an IBM PC 5150.

The original IBM PC was an 8-bit computer. (More on that later.) Using what I had learned in college by programming mainframe computers, I wrote a program to automate the chore of preparing navigation and fuel logs. After that, our squadron started churning out navigation logs in minutes instead of hours.

Before I got the program running, I upgraded to aircraft commander and was assigned to fly a mission our squadron only got once every few years and it required some unusual flight planning. We were required to fly just a couple of hundred feet above the water and head right at Russian spy ships decked out to look like fishing trawlers. These ships became known as AGIs, since the U.S. Navy classified them as "Auxiliary, General Intelligence." We were told they were armed and that it was best for us to fly as fast as possible, as low as possible. So, that's what we did. When I wrote the fuel-planning software, I made sure it

CREATIVE COMMONS

IBM PC 5150, circa 1982



U.S. NAVY

Soviet AGI, 1970

included the airplane's entire operating envelope. Job done.

A few years later I was an examiner pilot and none of our copilots could remember the days of having to chase through charts to compute fuel burns. They just plugged the navigation data into the software and out came the fuel log. In fact, that was true of many of our aircraft commanders. They just looked at the top line of the fuel log and ordered whatever it said.

However, when I saw that an "AGI Hunter" trip came up, I eagerly added myself to the schedule to administer a route check. The evening before the flight, I checked the crew's paperwork and thought the fuel load was a little light. Skimming each leg of the flight plan, I saw typical fuel burns of, say, "-5,500 lb." for a shorter leg and upward of "-20,000" for a long one, meaning that was how much fuel was "subtracted" from the tanks. When I got to the low-altitude, high-speed leg, the fuel burn was "+10,300 lb." In other words, they ended that leg with more gas than when they started. Considerably more. I called the logistics branch and added 20,000 lb. to the fuel order.

That night I examined my computer code, written many years before, and found the error. I was missing a multiplier for the legs flown at high speeds below 1,000 ft. MSL. Nobody had ever flight-planned that since I released the program and my oversight went unnoticed.

I briefed the crew about this before the flight and they were obviously concerned. Had they busted the trip before it left the ground? I joked that I would have to bust myself since I wrote the program. But I also gave them a few techniques to make sure they could catch this kind of error in the future.

Technophobe Technique. Try to develop an idea of how much fuel your airplane burns in various phases of flight so you can do some quick math to check the computer's prediction. I keep a few numbers in mind for my Gulfstream G500 loaded with enough gas to make it from Boston to London at a cruise altitude of 41,000 ft. (to keep both pilots off oxygen). I know we can usually make it to altitude using just over 2,000 lb. of fuel. We can then cruise at Mach 0.90 burning around 3,000 lb. every hour thereafter. If we wanted to stretch it, pulling back to Mach 0.85 saves us about 500 lb./hr. Let's say we want to know how much gas is needed to fly 5 hr. at the higher speed. I would say 2,000 lb. to climb, then 3,000 lb. each for hour. That comes to 17,000 lb. before alternate, reserve and other planning numbers.

Going Digital Means Going Binary

Of course, I was an amateur computer programmer using an 8-bit computer, which seems archaic by today's standard. But was does "8 bit" mean? We know it has something to do with the ones and zeroes of binary math, but what does that mean? It is all about counting.

Most of us humans have an instinctive understanding of "Base 10," a numbering system based on the total number of fingers on two hands. We have concocted 10 symbols (0, 1, 2, 3, 4, 5, 6, 7, 8 and 9) to represent varying numbers of things, including a symbol that represents no number of things. When it comes time for more than 9, we append a symbol to the left and that means that number of things times 10. For example, 29 means two times 10 plus 9 more. That continues as you add digits to the left with even greater multipliers. OK, we all get that. This system is very efficient, in that you can represent a very large number of things with a small number of symbols. We could say we have 1,347 of something, or we could draw a hash mark that many times. Base 10 is very convenient.

But computers don't have 10 fingers, so Base 10 is not how they "think." What a computer does have are lots and lots of switches. That's all a transistor is, after all, an electronic switch.

A simple transistor has three wires, using one wire to signal a "yes" or a "no" to allow current to travel between the other two wires. It is a basic switch that is either on or off; or we can say either 1 or 0.

Binary is "Base 2," which also has symbols for counting. They are "0" and "1" and operate much the same way Base 10 operates, but not as conveniently. That 0 and 1 are what constitute a "bit," which stands for "binary digit." Let's count from zero to four using bits: 0, 1, 10, 11, and 100. This is cumbersome, but it is the language of a computer processor.

If you put eight of these bits together, you end up with a byte. Here is the number 255:

11111111

That's 8 1s, or Base 8. If you wanted to convert this to decimal, you take each number, starting from the right, and use that as the exponent to the number 2 (because we are binary) and add everything together. The tricky part is that we have to reverse it and start with zero. So 11111111 comes to $2^0 + 2^1 + 2^2 + 2^3 + 2^4 + 2^5 + 2^6 + 2^7 = 1 + 2 + 4 + 8 + 16 + 32 + 64 + 128 = 255$.

This is significant because that means eight switches (on or off) can be combined to represent 256 numbers. (Remember to add the initial zero.) We have a standard called ASCII (American Standard Code for Information Interchange) that converts those 256 possible values into letters, numbers and other symbols. Let's say you wanted to represent the uppercase letter "A" for example.

The binary answer is a series of 8 bits: 0 1 0 0 0 0 0 1. You can convert this to the ASCII decimal by converting the 1s, reading from right to left. The first 1 is in the "0" position, so that comes to $2^0 = 1$. The seventh 1 is in the 6th position, so that comes to $2^6 = 64$. So, A is represented by $1 + 64 = 65$.

Let's try something a little longer, the number 4,294,967,295:

11111111111111111111111111111111

That's 32 1s, or 32 bit. If you own any "legacy" computers chances are they are 8-, 16- or 32-bit computers. You may even be flying an airplane using 32-bit (or earlier) computers. Depending on what your airplane is doing with those computers, this could be important.

An Air Traffic Control Center's Reboot

On Sept. 14, 2004, as many as 800 commercial airline flights bound for Southern California were diverted and departures were delayed for more than 3 hr. after radio and radar equipment failed at the Los Angeles Air Route Traffic Control Center in Palmdale, California. Radios went dead and radar screens went blank, all without warning. Controllers used their personal cellphones to contact other centers so the latter could contact and sort

FAA

Air Route Traffic Controllers

out the airborne traffic. There were no accidents, but at least 10 aircraft had what is euphemistically called a "loss of separation." News reports from the time said: "Exactly what went wrong was not immediately determined."

There isn't much official about the incident, but it seems it was due to a timekeeping error with the center's computers, which tracked the passage of time by starting with the number 4,294,967,295 and counting down once a millisecond. That number, you may recall, is what 32 bits comes to in Base 10.

Which meant that it would take 49 days, 17 hr., 2 min. and 47.295 sec. to reach zero. Can time go negative? Perhaps, but apparently not in this computer. Usually, the machine would be restarted before that happened, and the countdown would begin again from 4,294,967,295. I've read that some people were aware of the potential issue, so it was policy to restart the system at least every 30 days. But in this particular cycle, the computer ran for 50 days without a restart, hit zero, and shut itself down.

If you ever had a 32-bit computer that you allowed to go into "sleep mode" regularly rather than have to wait for the full boot-up process the next day, you may have noticed the computer crashed on you now and then. Perhaps it was 49 days since its last crash. Now you know why.

The fix would be to rewrite the code so that instead of shutting down, it simply restarted the count on its own. Modern computers these days are using 64-bit processors, which, if instructed to count backward from 2^{64} in milliseconds, would end up at zero in 584.9 million years. So, we can worry about this later.

Technophobe Technique. In the days following Sept. 11, 2001, a NOTAM was issued in the U.S. requiring crews to monitor emergency frequency 121.5 MHz, but that mandate was allowed to expire. In some parts of the world there are backup air traffic control frequencies. Well, guess what? There is a backup frequency here, too, and you should make use of it: 121.5 MHz.

The F-22 and the International Date Line

If you've ever flown an airplane that came right out of the factory you will probably have experienced what the U.S. Navy calls the shakedown cruise, an initial outing to shake out all the glitches. But in an airplane, the shakedown lasts several months. If you are flying a brand-new aircraft type, it could last years.

At the time of its introduction, the Lockheed Martin F-22 Raptor was the pride and joy of the U.S. Air Force. At $360 million per aircraft it wasn't cheap, but it represented the cutting edge in technology. In February 2007, a flight of six Raptors were scheduled to make their first deployment from Hawaii to Japan, on the wing of a refueling tanker.

All was going smoothly until they crossed the International Date Line, when the computers on all six fighters stopped working. The pilots were left without navigation, communications or fuel management. Attempts to restart the systems proved unsuccessful. Fortunately, their fly-by-wire systems were still working, they were able to visually signal the tanker to turn around, and they had enough fuel to make it

ROB SHENK

F-22 Raptor, May 17, 2008

back to Hawaii. The cause was said to be a "computer glitch in the million lines of code." The Air Force never confirmed what went wrong, only that it was fixed within 48 hr.

Technophobe Technique. Be mindful of an aircraft's limitations and history. If it hasn't been done before, realize you are a de facto test pilot and need to develop an exit strategy for those periods where you are quite literally flying into the unknown. A better plan would be to leave the experimental flying to the experimental test pilots.

The Boeing 787 and Dreams of Simpler Systems

In 2015, the FAA issued an Airworthiness Directive that, at first reading, seemed more of a prank than anything else. When have you ever heard of an aircraft electrical system with a calendar-based limitation? Well, here you go:

"This AD was prompted by the determination that a Model 787 airplane that has been powered continuously for 248 days can lose all alternating current (AC) electrical power due to the generator control units (GCUs) simultaneously going into failsafe mode. This condition is caused by a software counter internal to the GCUs that will overflow after 248 days of continuous power. We are issuing this AD to prevent loss of all AC electrical power, which could result in loss of control of the airplane."

"NEW YORK-AIR" PHOTO

Boeing 787-9 at the 2019 Paris Air Show

I read that AD from cover to cover for signs it was a joke. Why does a GCU care about the 248th day any more than the 247th? There were a number of "tech blogs" at the time that hypothesized there was a timer in the GCU that counted in 100ths of a second and that $100(2^{31}) = 214{,}748{,}364{,}800$ sec., which when divided by the number of seconds in a day equals 248 days and therefore the computer in the GCU couldn't multiply beyond 2^{31} for some reason.

But that makes no sense because 2^{31} means nothing in the computer world. But what if you dedicate the first bit of that 32-bit data register to a plus or minus sign? That would leave you with enough bits left over for 248 days, 13 hr., 13 min. and 56.47 sec. counting in 100ths of a second. The fix has been to require the airplane to be rebooted more often.

Technophobe Technique. As the aircraft I've flown have grown with complexity so has the "cold boot" process. I've noticed that if the boot-up process doesn't go the same way it usually does, chances are something isn't going to work correctly later in the flight. I think you should carefully watch and record what a normal boot-up looks like.

A cellphone video of the cockpit during a normal boot gives you a quick reference for when the boot-up just doesn't seem right. It may save you time in the long run to reboot as soon as you see the cold boot isn't progressing normally. After 10 years with the Gulfstream G450 we got pretty good at predicting this. If you are going to have to reboot anyway, it is better to get it over with early rather than have to do almost the entire preflight twice. We are now flying a new aircraft, and we are still learning. And still recording.

What Is a Line of Code?

You often hear manufacturers beg forgiveness for technical glitches by saying it was impossible to predict because of the millions of lines of code in the aircraft's computer systems. What does that mean? Consider a student computer programmer's first program, the so-called "Hello World Program" written in a computer language that is so basic, it is called BASIC (Beginner's All-purpose Symbolic Instruction Code).

```
10 PRINT "Hello World!"
```

That's one line of code. Now let's make it just a little more complicated:

```
10 PRINT "Hello World!"
20 GOTO 10
```

Now you have two lines of code and there is an error. The error is called an "endless loop" because the program will just keep printing "Hello World!" over and over without end.

It was an easy error to spot. The F-22 Raptor's error was said to be somewhere amongst 2 million lines of code. The error in my flight-planning software for the Boeing 707 was buried in just over 5,000 lines of code and the only way I found the glitch was to have someone actually attempt to fly the specific condition.

An Example of a Serious Line of Code Error

The Gulfstream GV was a game-changer in business aviation, offering unparalleled speed, range and efficiency. In 2004, the model was updated with the Gulfstream G550, the same basic airplane with a brand-new avionics package. The glass cockpit with four large display units (DUs) was revolutionary and has gone on to be the cornerstone of some very good cockpits in the Gulfstream stable. The airplane got its type certificate on Aug. 14, 2003.

The next year, a line of computer code caused all four DUs to go blank on at least one crew while in flight. Before the code could be rewritten, Gulfstream issued Maintenance and Operations Letter G550-MOL-2004-0020 recommending the following procedure if the DUs failed to recover within 90 sec.:

If DUs DO NOT recover, continue checklist with Step 7:

(7) Advise passengers that normal power will be off.

(8) Left and right generators (and APU generator, if in use) . . . OFF.

(9) Wait 30 seconds.

Gulfstream issued a software

MATT BIRCH, HTTP://WWW.VISUALAPPROACHIMAGES.COM

Gulfstream G550 on approach to Henderson Executive Airport (KHND), October 19, 2019

update (Aircraft Service Change 902) that fixed the broken code in December 2004, but the FAA followed up the next year with an Airworthiness Directive that said noise interference in the avionics standard communications bus would interfere with the display recovery.

Technophobe Technique. Can you imagine flying across the North Atlantic at night with nothing more than a standby attitude indicator? For around $600 you can buy a portable WAAS GPS equipped with ADS-B In and an integral backup attitude system that will link with an iPad. This setup could be a lifesaver the next time ATC shuts down, or you discover a broken line of software code. That is cheap insurance for a multi-million-dollar aircraft.

The avionics suite in the G550 is a work of art and I can imagine there must be millions of lines of code behind it. Is it surprising that a line of code made the wrong decision reacting to noise interference? I don't know, but I can certainly sympathize with the software engineers. What can we, as pilots, do about this? Let's look at one more example.

Example of a Nuisance Line of Code Error

We took delivery of our Gulfstream GVII-G500 within a year of the airplane's certification and we had on board a Gulfstream test pilot who was more than just a run-of-the-mill Entry Into Service (EIS) demo or delivery pilot; he really knew his stuff. The first thing we did was do three takeoffs and landings at Savannah/Hilton Head International Airport, Georgia (KSAV), each with an ILS approach and a quick reloading of the flight plan in the FMS, all handled by our EIS pilot.

We then loaded a flight plan to Laurence G. Hanscom Field Airport, Bedford, Massachusetts (KBED). The FMS initialized the route with a speed of 160 kt. and cruise altitude of 180 ft. Try as we might, we couldn't change that. Our EIS pilot called all the company experts and they all said, "We've never heard that one before." Finally, someone suggested pulling and resetting the Modular Avionics Units circuit breakers. That worked, but it made the cockpit go nuts. I told the EIS pilot, "Let's never do that again."

The pilots at Gulfstream were stumped. But how often did they fly a local pattern and then set up for a Point A to Point B trip? Perhaps never. I reached out to a GVII user's group and discovered that a few operators already found a workaround: Hit the Take Off/Go Around button on the thrust levers to fix things. That worked. After some experimentation, we discovered the problem only seems to happen after flying an ILS, shutting the engines down but leaving the avionics powered, and then entering or downloading another flight plan. We made several videos of the problem and now the avionics manufacturer is hunting for a line of code to fix for a problem never anticipated.

Technophobe Technique. Manufacturers and training vendors tend to live in sterile bubbles where conditions are largely predictable. There is no way they can anticipate and simulate every possible condition "out there" in the real world. It is in everyone's best interest if those flying a part icular aircraft type connect with the rest of the community and share experiences. In the few months I have been flying our new airplane I've already discovered a few problems that stumped Gulfstream and our training vendor but found answers in a user's group. "They" build the airplane or train us to fly it. But "we" have more relevant, real-world experience. We should share that knowledge.

Technophobia as a Survival Mechanism

Science fiction writer Arthur C. Clarke formulated a series of adages that became known as "Clarke's Three Laws" and of those, the third, applies: "Any sufficiently advanced technology is indistinguishable from magic."

It is tempting to think of those millions of lines of code that go inside our computers as magic. As such, only someone who thinks in ones and zeroes can hope to understand them and the rest of us are at the mercy of the magician. As modern-day aviators we are immersed in technology and the stakes are too high to leave our fates to sorcery. But we can anticipate the unpredictable by playing the "what if?" game and developing techniques to survive.

Technophobia, it would seem, is a valuable tool if used wisely. **BCA**

Rapid Icing Response

Two similar encounters **with very different outcomes**

BY **ROSS DETWILER** rossdetwiler.com

When winter arrives, as it soon will in the Northern Hemisphere and where it can linger, aviators need to become hyper alert for conditions that invite ice formation aloft. Given the right combination of temperature, moisture content, airfoil design and crew action, the result can be sudden, unexpected, confusing and potentially catastrophic. Two flights with drastically different endings underscore the concern.

On Dec. 20, 2011, at about 1005 EST, a Socata TBM 700, N731CA, collided with terrain following an inflight loss of control near Morristown, New Jersey. Visual conditions prevailed. The flight had departed from Teterboro, New Jersey (KTEB) 15 min. earlier en route to Atlanta. The private pilot and four passengers were killed and the airplane destroyed.

The 45-year-old pilot and his business colleague, a non-pilot, were in the cockpit. The pilot's wife, two children and a family pet were in the back. The pilot held a private pilot certificate rated for SEL and also an instrument rating. Approximately five months earlier, he had reported 1,400 total hours of experience when he took his second-class medical. His personal logbooks were not located after the accident.

Records indicate that the pilot took a two-day recurrent training course in the single-engine turboprop just over a month before the crash. The training addressed the technical aspects of the aircraft's installed ice protection and environmental systems including preflight checking or testing, along with normal and emergency checklists. Simulator training consists of system checking, testing and operation including operating in icing conditions, at altitude, and system malfunctions.

The TBM 700's *Pilot's Operating Handbook* — Section 2 Limitations — focuses on accumulation of ice on the upper surface of the wing aft of the protected area. It states that "since the autopilot, when operating, may mask tactile cues that indicate adverse changes in handling characteristics, use of the autopilot is prohibited when any of the visual cues specified above exist, or when unusual lateral trim requirements or autopilot trim warnings are encountered while the aircraft is in icing conditions." Indications were that the pilot had entered icing conditions with the autopilot engaged.

NTSB

Outboard section right wing, lodged in tree

On the morning of the accident, Teterboro Airport had 10 kt. of wind with relatively high ceilings. Somerset Airport (KSMQ) in Pluckemin, New Jersey, was reporting ceilings of 12,000 ft. just before the crash. KSMQ is 12 mi. from the crash scene. Later estimates on the icing level at the time of the incident put it between 13,000 ft. with some encounters lasting as high as 17,000 ft. There were numerous reports of icing in the hours before and after the accident although the NTSB report states that severe icing was not forecasted.

The pilot self-filed an instrument flight plan through the Direct User Access Terminal System (DUATS) in which he listed a cruising speed of 292 kt. and an altitude of FL 260. No record could be found of him receiving a verbal forecast. A clearance was issued at 0930 through Teterboro Airport Clearance Delivery at which point the turboprop began to taxi. The pilot contacted ground and taxied to KTEB's Runway 6, and at 0948, he reported that he was ready to depart. According to air traffic control (ATC) recorded communications, weather information was not requested by, nor issued to, the pilot.

A captain departing out of nearby LaGuardia Airport (KLGA) in a

McDonnell Douglas MD-80 about an hour ahead of the accident aircraft told the NTSB that he started picking up ice immediately upon entering the layer and that by the time the aircraft came out the top he estimated there was a 1- to 1.5-inch cone, 0.75 in. in diameter built up on the wiper blade locknut. He did not recall how thick the cloud layer was but estimated it was only a few thousand feet. His first officer stated that it was the heaviest ice he had ever seen. The captain said he had seen worse but would definitely not have wanted to stay in it for long.

An urgent pilot report was received at 0808 from a flight crew operating an MD-83 at 14,000 ft. over New Jersey's Morristown Municipal Airport (KMMU). The pilot reported moderate to severe rime icing between 14,000 and 16,500 ft. One of the flight crewmembers reported that the icing was the worst he had seen in 38 years of flying and that he had never seen ice accumulate so quickly. He described "golf ball-sized" accumulation on the windshield wiper.

An interview with the captain of a Bombardier CRJ that was operating close to the accident aircraft reported that the wing anti-ice system could not "keep up" with the accumulation. He estimated 2.5 in. of ice on the protected areas of the wing, and 4 in. accumulation on some unprotected areas in a time span of about 5 min.

During climb-out, while passing 8,000 ft. for 10,000 ft., the TBM pilot was directed to climb and maintain 14,000 ft. The controller then advised the pilot of moderate rime icing from 15,000 ft. through 17,000 ft., with light rime ice at 14,000 ft. The controller asked that the pilot advise him if the icing got worse, and the pilot responded, "We'll let you know what happens when we get in there and if we could go straight through, it's no problem for us." At 0958:24, the controller directed the pilot to climb and maintain 17,000 ft. and to contact New York Center (ZNY). While climbing between 12,800 and 12,900 ft., at 116 kt. ground speed, the pilot acknowledged and advised that they were entering instrument meteorological conditions (IMC).

At 1002:17, the ZNY controller advised the pilot that he would be cleared to a higher altitude when ATC could provide it, and that light icing would be encountered at 17,000 ft. The pilot responded, "I can confirm that light icing . . ." and added that, ". . . light icing has been present for a little while and a higher altitude would be great." The altitude of the airplane at that time was at 16,800 ft. and its ground speed was 101 kt.

At 1002:34, the TBM pilot reported, "We're getting a little rattle here. Can we ah get ah higher as soon as possible please?" The ZNY controller responded with "stand by" and coordinated for a higher altitude with an adjacent sector controller.

At 1002:59, the ZNY controller directed the pilot to climb and maintain FL 200 and the pilot acknowledged. At 1004:08, the airplane reached an altitude of 17,800 ft. before it turned about 70 deg. to the left and entered a descent. At 1004:29, while descending through 17,400 ft., and at 90 kt. ground speed, the pilot transmitted, "and N731CA's declaring . . ." No subsequent radio transmissions were heard from the pilot.

The final radar return at 1005:17 was observed at an altitude of 2,000 ft., about 600 yd. west of the main wreckage impact site. The previous return, recorded 9 sec. earlier, indicated 6,200 ft.

Accident investigators interviewed numerous witnesses who observed the airplane during the accident sequence. A consistent observation was that the airplane descended at a rapid rate, and was trailing smoke. According to some, it was "corkscrewing like an airshow airplane." At least five witnesses saw pieces of the airplane separate during flight or they observed the airplane descending without a wing attached.

The NTSB determined the probable causes of the accident to be: the airplane's encounter with un-forecasted severe icing conditions that were characterized by high ice accretion rates, and the pilot's failure to use his command authority to depart the icing conditions in an expeditious manner, which resulted in a loss of airplane control.

Five years, two seasons later and an ocean away, conditions repeated, but the outcome, thankfully, did not.

While departing Edinburgh Airport in Scotland on June 5, 2017, a Saab 340 regional turboprop (G-LGNB) with 33 passengers and three crew aboard encountered severe icing and turbulence. The flight had launched at 1402 for Sumburgh Airport, 250 nm north in the Shetland Islands.

Fully equipped for all-weather operations, the aircraft had wing and stabilizer deicing, engine and propeller deicing, and heating for the windshield, outside air temperature probe and angle of attack (AOA) sensor. Bleed air goes to the wing and stabilizer boots and the engine intake while electrical power activates the remainder of the ice protection system.

In the climb, the aircraft started pitching up and down as the autopilot, which was engaged, attempted to maintain the selected IAS. Suddenly, the turbulence intensified and ice began to form quickly. The stick shaker activated and the autopilot disconnected.

The copilot, who was the pilot flying (PF), attempted to accelerate the aircraft by reducing the pitch attitude. He then re-engaged the autopilot, but, after 13 sec., the stick shaker activated again and the autopilot again disconnected. Shortly afterward, the stick shaker activated for a third time and the copilot began a descent to accelerate the aircraft. The Saab lost around 500 ft. in the maneuver, during which it accelerated and recovered to normal flight. The crew did not select maximum continuous power during the recovery.

NTSB

From a review of the flight data recorder, it was seen that as the aircraft climbed through FL 100, perturbations of normal acceleration started to increase, consistent with the aircraft

encountering light turbulence. The OAT was -5°C. The turbulence then continued to increase in intensity, with variations in AOA that closely correlated with changes in load factor, pitch attitude and airspeed; the average airspeed was 162 KIAS at that time. The aircraft then briefly leveled off at FL 103 before climbing again.

Shortly afterward, the AOA increased rapidly over 1 sec. from just over 0 deg. to a recorded value of 5.3 deg., which coincided with the autopilot disconnecting; the airspeed was 160

KIAS and the pitch attitude was 6.3 deg. nose-up. The disconnect of the autopilot meant that the peak AOA value was in excess of the 5.3 deg. recorded as the system, in icing, disconnects the autopilot at an indicated AOA of 5.9 deg. The pitch attitude then reduced quickly to 2.8 deg. nose-up, before increasing to 13 deg. nose-up in 4 sec. During this period, the AOA varied rapidly, reducing to a minimum of -7 deg.

The autopilot was then re-engaged and the pitch attitude reduced to about 2 deg. nose-up. The airspeed reduced to 149 KIAS, after which it started to increase toward 160 KIAS. Thirteen seconds later, the aircraft pitched up quickly to 5.6deg.; the recorded AOA also increased rapidly, reaching 6 deg., and the autopilot disconnected once again; the airspeed was 159 KIAS.

The aircraft then briefly leveled off, during which the pitch and AOA both increased rapidly again, with the recorded AOA peaking at 6.3 deg. The aircraft then descended about 500 ft. to FL 105, during which time the airspeed progressively increased to about 190 KIAS. At no time during this period of the flight was engine power increased to the "maximum continuous" setting. The autopilot was then re-engaged, which coincided with a reduction in turbulence, and the aircraft climbed to its cruise altitude of FL 170.

The conditions at FL 130 were capable of supporting the formation of severe icing. Analysis by the manufacturer concluded that the aircraft was affected by a large increase in aerodynamic drag. This could have been due to ice or downdrafts or a combination of the two. Even if the downdrafts had been twice as great as the forecast calculated, the increase in aerodynamic drag indicated that the aircraft had probably encountered severe icing conditions.

Left wing, burned, found within main wreckage debris field

Saab also noted that the ice ridges, which the pilots saw behind the inflatable area of the deicing boots, corroborated the presence of severe icing. The copilot observed this about the time the airframe vibration began, but he did not discuss it with the commander because they were in the process of descending, to vacate the icing conditions. Also, the operating manual did not state that this was an indication of severe icing.

The evidence suggested that severe icing conditions were encountered by the time the aircraft climbed past FL 125 and that it remained in severe icing after leveling. The operating manual states that maximum continuous power should be used if ice accumulation due to "extreme icing conditions" causes a "large impact on performance" and the IAS decreases toward the minimum safe speed.

The aircraft has a stick-shaker channel for each control column and their vibration is reinforced with an aural warning in the form of a continuous clacker. At the same time as the stick shaker activates, the autopilot disengages. If sufficient action is not taken after the shaker and aural warnings are triggered, the stick push system provides a forward movement of the control columns to pitch the aircraft to a slightly nose-down attitude. If the stick push activates, visual warnings on the central warning panel and on the instrument panels also illuminate. The stall warning is generated by a combination of AOA, flap position and information from the wing anti-ice system.

A modification to the stall-warning computer adjusted the logic of the stick shaker and introduced the ice-speed system. This increased the stall-warning speed trigger levels to compensate for possible ice accretion on the wings. Notably, the triggering AOA for the stick shaker activation was lowered from 12.1 deg. to 5.9 deg., but the stick-push logic remained unchanged. This ice-speed function is activated by switching on the engine anti-ice system. It remains activated even when the engine anti-ice system is selected off because a separate ice-speed switch also must be selected off. The engine anti-ice system must remain on for 5 min. after exiting icing conditions.

The Saab was climbing in IAS mode in which the flight control computers adjust the pitch attitude of the aircraft in order to maintain the selected IAS. The mode was engaged with an IAS of 163 kt. The stick shaker was triggered three times by the aircraft AOA reaching 5.9 deg. The aircraft was in turbulence with its pitch and IAS varying. Meteorological reports showed that the weather in both Edinburgh and Sumburgh was affected by the presence of an occluded front lying just to the north of Edinburgh, moving eastward. There also was a warm front lying parallel to the occlusion. Visibility outside the cloud was good but there were isolated moderate or heavy showers. There also were isolated, embedded cumulonimbus clouds with bases from 1,500 to 3,000 ft. ASL and tops above 10,000 ft. Freezing levels were between 4,000 and 5,000 ft.

In reviewing the encounter and actions taken, the U.K.'s Air Accidents Investigation Branch determined that the aircraft's stall warning system "functioned as it was designed," and that the crew "did not initially address the problem sufficiently." However, after the third activation of the stick shaker, the pilots "descended the aircraft to regain a safe airspeed" and were able to "clear the icing and turbulent conditions" and continue on to Sumburgh without further incident. **BCA**

When Wing A Becomes B

Imagining what must have been going through the minds of the people in that TBM airplane is as gut wrenching as the final outcome was horrific. When the plane departed control, it fell like a stone. Some reports say that it appeared to have gained some control and seemed like it might pull out when it impacted. A family terrorized and snuffed in seconds.

By contrast, the Saab flight is so mundane that readers may wonder why I included it. There's a good chance that while all the machinations were occurring on the flight deck, the passengers were merely annoyed by the bouncing that was going on and were probably glad when they popped out into clear air.

Consider this. Both flights probably encountered the same type of conditions. The only difference was the Saab crew lowered their aircraft's angle of attack. One could say that the pilot had to be hit in the head twice (three times if you consider the shaker without autopilot engaged third warning) before realizing the need to unload the wing and get some airspeed. I think the design of the autopilot system, especially considering the ice flight module, is excellent. It tells the pilot, "This is not working out. Don't just sit there and watch. Do something."

When an aircraft enters moderate to severe icing, the ability to operate normally is drastically impaired. The common parameters that we use to control an airplane, namely angle of attack and airspeed, may have entirely different effects on the airplane than ever experienced. That is because, when the wing becomes coated with ice, the airfoil is changed. In other words, the pilot can wind up flying wing B while trying to use the familiar engineering parameters of wing A as it came from the factory.

Modern turbine-powered airplanes use engine bleed air to heat the leading edge of the wing to temperatures in the 130C range. Turboprops, such as the two cited here, may use air pumps or bleed-air pressure to inflate the boots on the wing. Even with these marvelous systems, the airfoil changes.

Probably the worst icing I ever saw

Not Ready, Set, Go

Brotherly distractions **produce an overrun**

BY **ROGER COX**

With few exceptions, turbojet-powered civilian airplanes are certified to be flown by two pilots, and operators staff accordingly. However, on occasion, a pilot in command has to find a replacement for the regular second in command. And while such replacements may be qualified according to FAR Part 61.55, they may not actually be ready to serve as effective crewmembers.

It's up to the PIC to make a wise and well-informed judgment about the new SIC's true qualifications for the position, however temporary. When that substitute is a relative or a friend, that judgment can be fraught with risk. It's very likely the dynamic between two familiar, close-knit acquaintances on the flight deck will differ from the more formal interaction of two pilots connected in a strictly professional capacity.

Friends and family members will tend to act casually, use slang terms, communicate non-verbally and have less focus on the command and subordinate roles. The more experienced of the two may try to compensate for the relative inexperience of the other.

Proper application of crew resource management (CRM) can go a long way toward allowing the replacement pilot to fit into your planned operation. CRM, or the application of team management concepts to the flight deck, emphasizes interpersonal communications, leadership and decision making. Good CRM provides a common mental model of the way the mission is going to be conducted. Such training has long been required at Part 121 airlines, but it is still a somewhat uncertain idea in many Part 91 operations.

A replacement pilot's misunderstanding of CRM and lack of proficiency contributed to an accident on June 18, 2012.

The owner of a Beechjet 400A (N826JH) had called his pilot who also managed his aircraft and asked him to schedule a flight from their home base of Gadsden, Alabama, to Atlanta and then on to Jacksonville, Florida, leaving two days later at around 0900. The pilot maintained a list of qualified SICs who regularly flew the airplane, but none were available on short notice. The PIC's brother, who had obtained a BE-400 type rating with "SIC privileges only"

was on a departure from New York's Westchester County Airport (KHPN) as we passed through 12,000 ft. With wing and engine heat on and the power at max continuous, the ice melted as soon as it formed, but the water ran back and re-froze on the area behind the leading edge. I've had plenty of icing events and usually it's fun to just watch the ice build and then melt off due to the heat. But this was no fun and we vacated the altitude as soon as possible. The rate of build-up was just too great.

So, we have three things going against us in severe icing situations. First, the wing will not act in accordance with the parameters stated in the operating manual. It cannot, because its shape has been altered. Second, if the autopilot engaged when that occurs, as was the case in these two flights and several others with very severe consequences, that system can mask very serious deteriorations in the performance of the wing that a pilot might otherwise be able to feel earlier if hand-flying the airplane. Third, the mention of a "rattle" just before the TBM departed was most likely the airframe beginning to shake due to the rapidly increasing turbulent flow behind the airplane wing and possibly the pilot's last chance for action to save the airplane. Had he then unloaded the wing by starting a descent, added power and let the airspeed build up, all aboard may have survived. Given that the ceiling was 12,000 ft., the best course of action would have been to stay there until south of Philadelphia and free of all the reports of severe icing. Unfortunately, there is no evidence the pilot knew of those reports. He flew as filed.

I retained the section of the report that describes the modifications made to the Saab's stall and pusher system to highlight a point. The engineers felt that the change in the shape of the wing could be so great that the pilot should be warned about it at an angle of attack of 5.9 deg. instead of the customary, clean-wing AOA warning that is received at 12-13 deg. What they were saying was that at an "indicated" AOA of 5.9 deg., with large amounts of ice, the "new wing" may fly about as well as the original did at over twice that angle of attack. **BCA**

NTSB

in 2007, was available but had not flown the plane regularly in recent years. Nevertheless, the PIC decided to go ahead and fly the trip with his sibling in the right seat.

Two days later, upon touching down at 1006 at Atlanta's DeKalb-Peachtree Airport (KPDK), the Beechjet overran the end of Runway 20L, crossed an airport service road, veered to the left and struck an airport perimeter fence before coming to a stop — upright, fortunately. The airplane was heavily damaged, both pilots were seriously injured, and the two passengers suffered injuries as well, but comparatively minor.

The NTSB determined the probable cause of the accident was the pilots' failure to obtain the proper airspeed for landing, which resulted in the jet touching down too fast with inadequate runway remaining to stop. Contributing to the mishap was the failure of either pilot to call for a go-around, their poor CRM and lack of professionalism.

The Flight

The flight departed Northeast Alabama Regional Airport (KGAD) in Gadsden at 0942 that Monday with the SIC flying from the left seat and the owner and one of his employees aboard. The jet was equipped with a cockpit voice recorder (CVR), and the PIC can be heard giving his brother dual instruction before and during the flight using a question and answer style.

To begin, the CVR did not record the use of a clear challenge and response checklist before takeoff. The PIC asked the SIC, "Who's flying the airplane?" to which the brother replied, "I'm flying the airplane." But the PIC corrected, "You say, 'I fly the airplane; you take care of the checklists.'" Shortly after takeoff, the PIC asked, "What you want your speed on?" and the SIC replied, "Uh, ninety six." At that, the PIC repeated the question, and the brother said, "Two fifty." The PIC replied, "All right, dial it in over there," and the SIC asked, "Is that it — outside or inside," and the PIC said, "Nope, right there. Two fifty. Turn it to the right — turn it, turn it, turn it. Don't fly * stall — two fifty down here." Shortly thereafter, the PIC asked, "You forgetting anything?" and the SIC responded, "I don't know — checklist — after-takeoff checklist." The PIC performed after-takeoff items and reminded the SIC he must call for the after-takeoff checklist.

The flight was cleared to maintain 5,000 ft. and intercept Victor 325. As the airplane approached the airway and the altitude, the PIC said "Capture that nav right there — take your range — take your hands off of that." At 0946:33, the CVR recorded an overspeed warning that lasted 13.9 sec. The PIC told the SIC to reduce thrust. He told the passengers, "That's my fault; no problem guys," but the owner said, "Oh, I thought we had a problem," and "I was thinking are we fixing to crash?" To the SIC, the PIC said, "See how quick it'll get away from you?" and

then, "Scan . . . scan." Atlanta Center next cleared the flight to climb to and maintain 13,000 ft. and the two pilots had a discussion about the use of the vertical speed mode of the autopilot. The PIC said, "You get above 10,000 — you're fixing to overspeed again."

At 0951:16, Atlanta Center cleared the flight to cross CARAN at 8,000 ft. The SIC did not hear the clearance, prompting the PIC to ask, "How's your headset working?" Atlanta Center then revised the clearance to cross 13 west of DALAS at 8,000 ft.. Over the next 4 min. the pilots had a more or less continuous conversation, with the PIC coaching his brother on how to use the vertical speed control and set the power to manage the descent, but the SIC was having difficulty. During the descent the PIC said, "You hear me? All right, do something with that vertical speed if you're gonna go back to 8,000." And 24 sec. later, the PIC cautioned, "I wouldn't power up in a descent. Pull power; pull power back."

At 0955:45, the flight checked in with Atlanta Approach and was cleared to descend farther to 5,000 ft. The PIC did not include the ATIS on his initial call, so Approach Control said, "Advise when you have information India." During the next 30 sec., as the PIC attempted to listen to the ATIS, his brother interrupted him four times with questions.

At 0959:05, after receiving further clearance to 4,000 ft., the SIC said "I can't get vertical speed to work at all," and after another verbal exchange the PIC said, "Disconnect the autopilot and hand-fly." At 1002:58, the PIC said, "I want you to learn how. When you say it's not working, you gotta look around."

The flight was cleared direct to the airport and down to 3,000 ft. and asked to call the airport in sight. At 1003:22, the PIC called the airport in sight, received clearance for a visual approach to Runway 20L, and was instructed to contact the tower. Upon initial contact, the tower said, "Traffic's a Cessna 5-mi. final for the right side — Runway 20 left clear to land. That traffic is at 2,200 indicated."

In the next 2 min. and 20 sec. before the end of the CVR recording, there were 48 verbalizations or warnings — 10 tower transmissions, four calls from the Cessna, one TCAS warning, five TAWS warnings, six radio calls from the Beech crew and 22 crew statements — on average, one every 3 sec.

At 1004:23, the tower said, "Beech Juliet Hotel previously called traffic 12 o'clock two and a half miles 2,000 indicated," then, "November Six Juliet Hotel advise maintain present altitude until you have that aircraft in sight — he's at 2,000." The PIC replied, "Six Juliet Hotel we're looking — no joy."

At 1004:37, the PIC told the SIC, "All right. What do you want? Don't speed up now you're fixing to land," followed immediately by the SIC stating they were instructed to maintain altitude. At 1004:41, the controller advised the Cessna pilot that the Beechjet 400A was "a mile off your right side 2,300 indicated." At 1004:42, the CVR recorded, "traffic, traffic." The PIC saw a blinking yellow target ahead of their position on the TCAS display, but the SIC did not see the TCAS display because he was looking outside the cockpit.

Despite never seeing the Cessna, the Beechjet crew continued their descent on base leg, crossing over the top of the other airplane. At 1005:05, the PIC said "let me see a second," and took control of the airplane without verbalizing doing so. At 1005:21, the SIC said "before-landing checklist," but he was interrupted by an aural caution "sink rate, sink rate." The PIC replied "done." However, the airplane was not fully configured for landing.

The TAWS announced either "sink rate" or "pull up" warnings multiple times as the airplane approached the runway. The PIC said "way too fast" but continued the approach. The tower controller said in an interview that he saw the airplane touch down abeam the VOR/DME station.

After touchdown, the PIC applied the wheel brakes, but the airplane did not decelerate as expected. He was startled by the fact that the brakes were ineffective, and did not deploy the speed brakes or thrust reversers. When he saw the airplane would not stop by the end of the runway, he steered it away from the localizer antenna to avoid a fire. The CVR recorded the sound of the airplane touching down at 1005:55 and the sound of impacts at 1006:12.

The Investigation

The 66-year-old PIC held an airline transport pilot (ATP) certificate with an airplane multiengine land rating and type ratings in the CE-500, BE-300, BE-400, MU-300 and HS-125. He held a first-class medical certificate with the limitation "must wear corrective lenses" and received a special issuance due to sleep apnea, high blood pressure and related medications.

His reported total flight time was 10,800 hr., which included 1,500 hr. as PIC in the BE-400. He reported having 25 flight hr. in the previous 30 days and 100 hr. in the previous 90. He completed a BE-400 recurrent PIC course at Simcom on Dec. 22, 2010, and a Hawker 800XP initial at FlightSafety International on Sept. 25, 2011.

A contract pilot, he also provided flight and aircraft management services through his own company. He had managed the accident airplane for five years and a King Air for the same

NTSB

company before that. He stated he had received normal rest in the three days before the accident.

The SIC was 68, held an ATP with an airplane multiengine land rating and type ratings with SIC privileges only for the BE-300, BE-400 and MU-300. He held a second-class medical certificate with a limitation to have glasses available for near vision. On his most-recent medical examination he had failed the normal color vision test but passed on the basis of a statement of demonstrated ability that had been administered in 1997.

He stated he had 3,500 hr. of flight time and 150 hr. in the BE-400, and he also said he had flown 9.7 hr. in the Beechjet the month before the accident. He estimated he had made 15 to 20 landings in that airplane. However, he could provide no logbook verification.

His most-recent training was a Beechjet 400A recurrent SIC course

taught by his brother in April, two months before the accident. His name had not been entered in the aircraft logbook during that time. When asked what his CRM training involved, he said "V speeds, flap speeds, standard callouts, climb-outs." He had normal rest before the accident flight and had no major health or personal issues. He was not a professional pilot but had been paid to fly on occasion.

The airplane was manufactured in 1993 and was certified under Part 25 for two crewmembers. Its total flight

time was approximately 4,711 hr. The maximum flap extend speed for 10 deg. of flaps was 200 KIAS and the maximum flap extend speed for 30 deg. of flaps was 165 KIAS. An electrically powered anti-skid system was designed to release brake pressure when a skid was detected by a wheel speed transducer. The maximum deploy cycle time of the thrust reverser lever was 1.6 sec. at 100 KCAS.

Investigators found the nose and left main landing gear separated but close to the airplane and the right main landing gear separated but lodged between the aft wing root and fuselage. The fuselage was fractured at the front pressure bulkhead and aft abeam the engines. There was no evidence of fire. Both flaps were retracted, although the flap selector in the cockpit was at 30 deg. Both thrust reversers were stowed, the speed-brake switch was retracted, and the anti-skid was on. No failures were found in the flight control system. The horizontal stabilizer jackscrew was positioned at -3.6 leading-edge angle, which corresponded to 2.3 deg. from full nose-down trim. No failures were found in the flap system components. An examination and testing of the brakes and anti-skid system showed no evidence of failure.

An enhanced ground proximity warning system (EGPWS) was recovered from the aircraft, downloaded and evaluated by a specialist in the NTSB Vehicle Recorder Lab. In addition to the cautions and warnings already heard on the CVR, the EGPWS recorded data included airplane heading, GPS position, GPS altitude and vertical speed. Ground speed was derived from aircraft position information. The last recorded position was 0.5 nm from the displaced threshold of Runway 20L at KPDK. At that point, the airplane's altitude was 153 ft. AGL,

Both thrust reversers were stowed, the speed-brake switch was retracted, and the anti-skid was on.

the calculated ground speed was 194 kt., and the descent rate was greater than 2,150 fpm. The stab trim position corresponded to the 194-kt. ground speed determined by the EGPWS data.

When investigators calculated the airplane's weight and balance, they found the flight was within limits, the appropriate Vref for landing was 115 kt., and the unfactored dry runway landing distance was 3,505 ft. (The unfactored landing distance is not adjusted for any safety margin additives.) The winds were variable at 3 kt. and the visibility was 8 mi.

EGPWS Data

KPDK's Runway 20L was concrete with diamond-ground grooves and had a positive gradient of 0.2%. The runway length was 5,001 ft. (excluding the displaced threshold), but the published landing distance was 4,801 ft. due to the proximity of the airport boundary fence. There was a two-light precision approach path indicator (PAPI) on the right side of Runway 20L, which provided a 3-deg. glidepath. A VOR/DME was located 2,031 ft. down the runway from the displaced threshold, resulting in 2,970 ft. remaining from abeam the VOR/DME to the departure end of Runway 20L. The airport director said an engineered materials arrestor system (EMAS) was to be installed in 2015.

Findings

Explaining the probable cause, the NTSB said the flight crew demonstrated poor CRM, evidenced by poor communication, lack of crew monitoring and lack of situational awareness. They did not perform a standard transfer of control, failed to adhere to ATC instructions, did not verbalize checklists, and failed to monitor and cross-check each other. Furthermore, the brother-pilots were unable to visualize their position relative to the Cessna despite ATC assistance and onboard TCAS audible and visual alerts. The Safety Board further found the SIC's lack of proficiency caused the PIC to coach/instruct him, which distracted the latter from his duties and reduced his situational awareness.

The PIC heard the "sink rate" and "pull up" warnings but ignored them. He knew he was "way too fast" on final approach but never checked to see if the flaps were down. He did not deploy the speed brakes, which, if deployed, would have put the weight on the wheels. He claimed the brakes malfunctioned, but intermittent skid marks showed the anti-skid system was working properly, applying and releasing the brakes in response to skidding. Had he deployed the thrust reversers, it might have reduced the airplane's speed when it hit the fence, and lessened the resulting damage. He said he didn't go around for fear of colliding with the Cessna, but he had quite deliberately crossed the Cessna's flight path without seeing it just a few moments earlier.

The PIC overloaded himself by putting his very rusty brother in the left seat and continuing to give him instruction even when a collision was imminent, and then he continued the approach without any semblance of adherence to checklists, callouts, aural warnings or stabilized approach criteria. The brother belied any knowledge of CRM by failing to make callouts, run checklists or insist on a go-around.

The role of a replacement pilot is not just to support you in doing what you want to do, but also to monitor your actions, decisions and errors, and to call them out, forcefully if necessary. By doing so, that substitute may just save you from yourself. **BCA**

Author's note: I participated in this investigation as the group chairman for operational factors.

Staying Connected

An otherwise unpleasant year, **2020 delivered good news** for connected business aviation users

BY **MAL GORMLEY** malgormley@gmail.com

Among the many companies and individuals, inflight connectivity (IFC) providers have been hit hard by the COVID-19 pandemic. Travel restrictions, continuing concerns about airborne particle transmissibility and the sudden widescale embrace of virtual meeting technologies combined to dramatically reduce airline travel this year, with carrier traffic down by 50% or more from 2019 levels. Business aviation travel also collapsed in the first half of 2020.

Consequently, about one-third of Gogo's 5,700 business jet air-to-ground customer accounts cut their spending, including 940 account suspensions and more than 750 service plan downgrades. With the flood of red ink rising, the company sold off its commercial aviation service to Intelsat (more on this later).

The extended outlook for IFC activity depends largely on how quickly business aviation and, more significantly, the airlines return to a semblance of normalcy, which could take years. Nevertheless, there are bright spots and significant developments in connected aviation. What follows is our annual summary of IFC product and services trends and developments.

Let's begin with Wi-Fi. Inflight connectivity in today's business aircraft is viewed by many as an essential tool, but we wondered how much of the fleet was so equipped.

"We were surprised to learn that only 34% of the worldwide business jet fleet currently listed for sale were identified as Wi-Fi-equipped," observed Rolland "Rollie" Vincent, a well-known business aviation consultant and creator and director of the Jetnet iQ market reports and summits. Jetnet conducts a proprietary global survey of 500+ aircraft owners and operators every quarter to measure the pulse of the community.

Vincent said that while installing Wi-Fi systems, particularly on older and lower-valued aircraft, can be complex and costly, "it is becoming increasingly clear that no office in the sky is complete without a way to stay connected. Whether you call it high-speed data, broadband or simply Wi-Fi, inflight connectivity in today's business aircraft is essential for taking care of business.

He explained that the finding that only one-third of business jets are so equipped was based upon an assessment of more than 2,000 aircraft on the market at the time of the poll. And that review of "a pretty diverse fleet" suggested that the

COLLINS AEROSPACE

unequipped aircraft tended to be older. "My sense is that owners/operators are more than aware of the demand from the back of the cabin," he noted, "but [they] need to make rational evaluations of the aircraft residual value in relation to the costs of an upgrade, and, of course, the availability of STCs."

By contrast, "With newer models, it is pretty clear that a large majority of buyers are loading up their aircraft with the latest/greatest avionics and cabin systems, as well as cost-per-hour program subscriptions from the outset."

Other factors to consider are whether the aircraft's cabin management system (CMS) provides access to all media installed without traditional Wi-Fi, and if the operator plans to add Wi-Fi upon the next aircraft acquisition or cabin connectivity upgrade.

IFC Provider Roundup

Alto Aviation

A New System Master Controller

Alto Aviation, a Sterling, Massachusetts, inflight audio and entertainment system manufacturer, recently expanded its cabin product line of systems interfaces and controllers with the Alto System Master Controller (SM-1070). It is a module designed to link aircraft CMS components with various communication protocols. The unit was developed by in-house cabin systems engineers to provide wireless remote control of components, via personal electronic devices (PEDs) or touchscreens, using the existing Wi-Fi or local area network (LAN) system on board the aircraft. Devices supported include a range of Alto products as well as other suppliers' audio and entertainment offerings.

The SM-1070 provides control of a variety of digital devices using Alto's Cadence keypads and supports PED-based remote control with Apple or Android operating systems. The new System Master Controller also acts as a universal bus translator, providing bus interface connectivity between existing Alto products and products from other manufacturers, and supports RS-485/RS-422, RS-232, Ethernet, CAN (controller area network), IR control (infrared) and ARINC 429 protocols.

Collins Aerospace

Connecting With Iridium Certus

Collins Aerospace recently connected and transmitted data to an orbiting Iridium satellite using the Iridium Certus service. The feat was accomplished using Collins' new Active Low Gain Antenna (ALGA), making it the first successful airborne equipment transmission of this type over the upgraded Iridium constellation's L-band broadband service.

This latest satcom system from the Cedar Rapids, Iowa, manufacturer is currently in development and is expected to be available to operators in 2022. Collins will provide all of the airborne hardware for the new system, including the satcom data unit (SDU), SDU configuration module (SCM) and the antenna. Depending on the operator's bandwidth requirements, either a low-gain or high-gain antenna can be included, providing L-band bandwidth to 176 Kbps or 704 Kbps, respectively.

In addition to faster speeds, the new system should have a lower weight and smaller antenna footprint for minimum drag and lower power usage than legacy systems.

LuxStream on Gulfstreams

Western Jet Aviation, based in Van Nuys, California, and Collins expect to soon complete KuSAT-2000 STCs that will enable LuxStream connectivity service on popular Gulfstream models. Platforms include the Gulfstream G350, G450, GV and G550 aircraft. LuxStream, launched in late 2019, offers speeds of up to 25 Mbps in the U.S. and 15 Mbps globally via SES's managed Ku-band satellite network.

The new product is available as part of Collins' ARINC-Direct portfolio of services. It will provide customers with bandwidth capable of supporting multiple streams of ultra-high-definition content, all while fellow passengers are concurrently running other apps. Available with flexible pricing, it is a one-point, turnkey system with both hardware and service provided by Collins.

LuxStream uses SES's global geostationary high-throughput satellite network. Its performance has been validated extensively with more than 25 passengers able to easily access the internet and stream entertainment content to their personal devices at 25 Mbps simultaneously.

Additional LuxStream STCs were anticipated by the end of the third quarter of 2020.

Duncan Aviation

Gogo Biz 4G Deal Still On

To ensure the best connectivity experience for its Gogo Business Aviation Avance L5 inflight Wi-Fi system customers, Duncan Aviation is extending the free-of-charge period for Gogo Text & Talk and Gogo Vision inflight entertainment to one full year. The recent Intelsat purchase of Gogo's commercial services will not affect any of Duncan's business with Gogo.

The limited-time offer allows operators to install the Avance L5 hardware that connects to the Gogo Biz 4G network, delivering faster speeds and enhanced network capacity. Duncan then gives them 12 months of unlimited access to Gogo Text & Talk and Gogo Vision subscription services.

Gogo Text & Talk lets an aircraft's crew and passengers use their personal smartphones and devices to call and text in the air just like they do on the ground. Meanwhile, Gogo Vision lets passengers watch movies and television shows, read popular magazines, view flight maps and more on their own devices during flight.

Duncan Aviation has nine STCs for the Avance L5 system that cover the Wi-Fi certification and full equipment and antenna installation required to provide inflight connectivity. These STCs are available for a growing list of aircraft makes/models including:

- Bombardier Global Express, XRS, 6000, and 5000; Challenger CL-650, CL-605, CL-604, CL-601-3A and CL-601-3R; and Challenger 300 and 350.
- Cessna Citation 680.
- Dassault Falcon 900, 900EX (EX, EASy, LX, DX), 2000 and 2000EX (EX, EASy, LX, DX, LXS, S).
- Gulfstream GIV, G300, G400, GIV-X, G350 and G450.

The Duncan Aviation STCs have been used for nearly 200 Avance L5 system installations. The company has installed more than 1,000 Gogo connectivity systems over the years and is Gogo's exclusive AOG service partner.

Duncan can install the Gogo Avance L5 system at its three main facilities (Battle Creek, Michigan; Lincoln, Nebraska; and Provo, Utah) and at its 28 avionics satellite shops and stations.

Global Eagle Entertainment

Airconnect Go 2.0 Launched

Global Eagle Entertainment has launched Airconnect Go

AIRCONNECT

Global Eage's second-generation Airconnect Go has no hardward activation fee.

GOGO

Gogo Avance L5 provides 4G service to business aircraft of all types.

2.0, the second generation of its battery- or aircraft-powered portable, wireless inflight entertainment system, one that lets passengers stream media content to their own devices.

Airconnect Go 2.0 reduces touchpoints in flight as passengers do not need to engage with onboard screens, instead using their own smartphone, laptop or tablet to access over 3,500 hr. of content including movies, TV series, music, podcasts, digital publications, games and an interactive flight tracker.

The upgrade provides 15 hr. of continuous service and expandable storage capacity, double that of the previous iteration. There is no hardware to install and it delivers instant results, offering curated content to entertain travelers.

Global Eagle's second-generation Airconnect Go has no hardware activation fee, is compact and weighs 7 lb.

New, lower pricing for optional accessories is available, including an aircraft-powered version, a PA Pause Dongle to automatically pause media playback during onboard announcements, and a mounting tray.

Gogo

Turns Total Focus on BizAv

Aviation connectivity provider Gogo is selling its commercial aviation unit to bankrupt satellite services provider Intelsat for $400 million in a deal that may help the latter return to a viable business while Gogo focuses on its fiscal health and business aviation services. The transaction, which is expected to close before the end of first quarter 2021, remains subject to customary closing conditions and regulatory approvals.

The deal will combine Intelsat's high-throughput satellites with Gogo's 2 Ku antenna to better position Intelsat in an inflight connectivity market that is expected to grow by double-digits in the long-term, despite COVID-19.

Proceeds from the deal will be used to improve Gogo's finances, allowing it to invest in new services in the "attractive and underpenetrated" business aviation market, including Gogo 5G, according to the Broomfield, Colorado, company.

Meanwhile, Gogo lost its patent suit against SmartSky Networks last April. Gogo had filed the challenge before the U.S. Patent and Trademark Office against a patent that SmartSky said covers some of the most-essential features of its air-to-ground (ATG) network.

Gogo Avance Installed on 1,000+ Business Jets

Things aren't all bad, however. In addition to 1,000 previous L5 installations, Gogo is nearing 450 ATG installations for its Avance L3 system. By the end of second quarter 2020, Gogo Business Aviation reported 5,399 aircraft flying with its systems onboard.

Gogo Avance L5 provides 4G service to business aircraft of all types and sizes and offers an upgrade path to Gogo 5G service when it launches. From the time Avance L5 launched in fourth quarter 2017, more than 325,000 flights have taken off with the system onboard, flying more than 420,000 hr. and 211 million mi., with users consuming 150 million megabytes of data.

Gogo, its OEM partners and dealers have seen adoption of both Avance L5 and Avance L3 on a retrofit basis with more than 200 STC approvals from the FAA. Both the L3 and L5 systems are factory-installed options on the majority of business jets of all types and sizes from the world's largest business aircraft manufacturers.

The Gogo Avance L5 system connects to the Gogo Biz 4G network, delivering faster speeds and enhanced network capacity and enabling activities such as livestreaming video and audio, videoconferencing, on-demand movies, faster web browsing, personal smartphone use, real-time data for cockpit apps, and remote diagnostics and support while in flight.

Early in 2018, Gogo launched its Avance L3 system that delivers the benefits of the Gogo Avance platform to passengers and flight departments in a lightweight, smaller form factor compared to the L5. Avance L3 allows users to customize their inflight experience based on their unique needs and can be installed on business aircraft of all types including turboprops and light jets.

Also, on July 20, 2020, Gogo lowered the altitude at which passengers can begin using its connectivity services — from 10,000 ft. AGL to 3,000 ft. AGL — for a significant portion of its ATG fleet.

Satcom Direct

A New Network Operations Center

With a larger footprint, the addition of cutting-edge technology and installation of a 72-by-10-ft. digital wall displaying real-time global customer connectivity activity, Satcom Direct has completed an upgrade to its Network Operations Center (NOC) at its headquarters in Melbourne, Florida.

The new facility is designed to intelligently aggregate,

With the addition of cutting-edge technology and installation of a 72-by-10-ft. digital wall displaying real-time global customer connectivity activity, Satcom Direct has completed an upgrade to its Network Operations Center (NOC).

SATCOM DIRECT

collate and analyze the increasing amounts of data generated by business aircraft activity. Information collected from the SD Xperience nose-to-tail portfolio of hardware, software and infrastructure solutions helps ensure the center's personnel are fully aware of the network status of each customer's aircraft globally.

By combining artificial intelligence (AI) and machine learning, data is aggregated and displayed on the enlarged screen. The upgraded technology can identify systemic issues across the partner satellite networks to support implementation of remedial measures and reduce user downtime if an issue occurs.

MySky Launched, World Fuel Interfaces

Satcom Direct is also offering a pair of new applications to assist its clients.

MySky, an AI-powered spend management platform designed for the private aviation industry, and Satcom Direct have launched a strategic alliance enabling ready access to real-time data for private aviation. Subscribers to MySky and SD get an all-encompassing approach to aircraft management that combines operational and financial information into a single source of data, the SD Pro platform.

MySky provides access to financial data and proprietary IT tools that can help owners and operators reduce costs, refine spending and improve the overall aircraft ownership experience. SD Pro's digital management dashboard provides relevant and timely information about pre- to post-flight aircraft performance to aircraft operators around the world.

In addition, SD customers can view their contracted fuel pricing at each stop on their trip. World Fuel Services subscribers can integrate their data into Satcom Direct's SD Pro PreFlight module. The feature centralizes planning information from multiple sources into a single dashboard. Operators can verify crew and aircraft availability, view trip calendars and communicate trip changes with one central login. Key trip details such as passenger profiles and standard industry fare levels are also captured to optimize post-flight reporting.

New Tail-Mounted Antennas

Satcom Direct is also expanding its hardware portfolio with the launch of a new tail-mounted antenna series. The system offers two variants for operation in Ku- or Ka-band frequencies. The former variant is expected to be available in early 2021, followed by the Ka-band version later in the year. SD has partnered with Inmarsat for Jet ConneX service and Intelsat for FlexExec connectivity.

SkyTrac

Production of Iridium Certus Terminals

Iridium Communications has announced SKYTRAC as the newest aviation value added manufacturer (VAM) for the Iridium Certus 9810 transceiver. Already an Iridium Certus service provider, SKYTRAC will now be able to both manufacture equipment and provide service to customers across the aviation industry.

Designed for optimal size, weight and power (SWaP), SKYTRAC's new SDL-350 terminal will be a 2-MCU satellite communications system, planned for market introduction in 2021. The new terminal will offer broadband speeds of up to 352 Kbps both to and from the aircraft. Built for the only L-band broadband platform providing truly global connectivity, the SDL-350 also takes advantage of the Iridium Certus platform's flexibility to scale device speeds, sizes and power requirements based on the needs of the end-user.

SKYTRAC is also producing the ISAT-200A-08 terminal for the Iridium Certus 9770 with 22/88 Kbps mid-band speeds. That should bring a 10x bandwidth improvement, as compared to Iridium's narrowband services, to operators using internet voice communications and streaming, while providing real-time alerts, advanced situational awareness and more.

The SDL-350 terminal is designed to handle applications like flight data monitoring, onboard electronic flight bag (EFB) capabilities, real-time health and usage monitoring (HUMS), medical data transfer, Voice over Internet Protocol (VoIP) communications and Global Aeronautical Distress and Safety System (GADSS) compliance functions. It is intended to aid in situational awareness, connected aircraft solutions, large file transfers and more, depending on the terminal's bandwidth level.

The new terminals should provide capabilities for a wide range of operators including those involved in aerial firefighting, executive transport, emergency medical services/search and rescue, oil and gas production, and law enforcement, among others.

SmartSky Networks

Partnering With IATA to Tackle Turbulence

In order to enable safer, smoother flights aboard commercial and business jets, SmartSky Networks is collaborating with the International Air Transport Association (IATA) to bring its open digital services to the association's Turbulence Aware platform.

Turbulence Aware helps aircraft operators mitigate the impact of turbulence, a leading cause of passenger and crew injuries and higher fuel costs each year, by pooling and sharing anonymized turbulence data from multiple participating airlines and thousands of daily flights.

SmartSky intends to significantly broaden the scope of the program by introducing business jet-reported turbulence data for the first time and thereby grow global live turbulence coverage beyond the data currently received from commercial airlines. As a result, business aviation operators can now be alerted to turbulence during flight planning and while in flight.

Powered by SmartSky's Skytelligence, and distributed over its ATG network, the turbulence service will enable pilots and control centers to improve the safety of flight operations, while passengers will experience smoother, more efficient flights.

Envoy includes three inegrated avionics modules: a CMU, VDR and a MCDU.

New Standards for Secure IFC

Cybersecurity is a top priority as connected aircraft become the norm in business aviation. As more operators of critical infrastructure and facilities move to support remote work, they're increasingly vulnerable to cybersecurity issues. Flight departments, pilots and passengers need to be confident the onboard network is protected from cyberattacks and other intrusions. New cybersecurity tools are available.

Honeywell Forge

Honeywell's latest release of its Forge Cybersecurity Suite includes several enhancements to help ensure business continuity in the face of mounting cyberthreats, uncertain global business conditions and continued supply-chain disruption associated with remote operations.

The new release (R200) incorporates new features such as enhanced industrial-grade remote access, increased asset discovery capabilities with active and passive functionality, and improved cybersecurity risk monitoring.

The enhancements come as more industrial organizations are embracing remote operations to effectively manage facilities with reduced numbers of onsite personnel due to current safety restrictions. A new Honeywell report indicates that the severity of cyberthreats detected to operational technology (OT) systems has risen by significant amounts in a 12-month period.

The Forge Cybersecurity Suite provides users with a single dashboard to centralize security operations and asset security management. Cybersecurity teams can provide and manage remote access to vendors with greater security and ease, allowing these teams to better monitor cyber risks and operational health inside their environments.

Forge is available in three versions: Enterprise Core, Enterprise Premium and Site. Customers can scale as needed to match their security requirements and budgets. It can be deployed either as a subscription or through Honeywell Managed Security Services.

With more than 4,000 installations worldwide, Honeywell Forge Cybersecurity technology helps customers ensure business continuity by:

- ▶ Providing an end-to-end approach to aerospace cybersecurity.
- ▶ Protecting passengers, employees and assets from cyberattacks.
- ▶ Using predictive analytics to proactively address potential threats.
- ▶ Embedding technical controls to protect all domains.
- ▶ Managing data use and cost without impacting the user experience.
- ▶ Enabling users to access flight-planning and flight-efficiency services in real-time — viewing real-time performance data and alerting them when an operational issue needs attention.
- ▶ Tracking the location and status of one aircraft or an entire fleet.
- ▶ Sharing critical data.

Spectralux Avionics

TSO Approval for Envoy

Following TSO approvals from the FAA, Redmond, Washington-based Spectralux Avionics' Envoy very-high-speed digital data-link communications unit is available to business jet operators. It provides global Aeronautical Operational Control (AOC) Aircraft Communications Addressing and Reporting System (ACARS) messaging through a highly customizable user interface. Envoy's certification also paves the way for Spectalux's Envoy Dual Stack unit.

Envoy includes three integrated avionics modules: a communications management unit (CMU), a VHF data radio (VDR) and a multipurpose control and display unit (MCDU). Envoy also features software applications for global data-link communications.

"This TSO approval is a significant milestone in the Envoy Data Link family," said Spectralux President Scott McCammant. "Envoy is a standalone unit that enhances safety and efficiency for global communications, navigation and surveillance (CNS) air traffic management (ATM). Envoy provides AOC ACARS functions over VHF and satcom, and, most importantly, Envoy is available now."

Viasat

Enhanced Ka-Band Connectivity for Business Aviation

IFC provider Viasat has removed internet speed limits delivered to the aircraft across all of its business aviation Ka-band service plans. Additionally, the Carlsbad, California, company has doubled its minimum committed internet speed to the aircraft for the same Ka-band service plans. That's intended to improve the experience with apps such as videoconferencing, accessing VPN/cloud content, email, high-definition streaming services, live TV and more. Ka-band customers also have the option to subscribe to Viasat Unlimited Streaming, which allows passengers to access online media services without impacting monthly data allowances.

The Viasat Ka-band business aviation IFC system uses the company's Global Aero Terminal 5510, which taps into the ViaSat-1, ViaSat-2 and European Ka-band satellite platform, and is expected to be with Viasat's next-generation satellite systems. That allows customers to install the Viasat shipset and subscribe to a Viasat service package now, with assurances that they can access additional satellite capacity, including larger data volumes and expanded coverage, once Viasat launches its ViaSat-3 satellite constellation.

In July, Viasat announced that its high-speed Ka-band business aviation service will be available aboard new and

Meanwhile, Honeywell's Cybersecurity Assurance Center specializes in data collection, penetration testing and predictive analytics that enable operators to take preventative action rather than wait to respond after a cyberattack occurs. Honeywell says flight departments may be able to save upward of $100,000 per aircraft per year by using Forge.

SAVCOM

SAVCOM has launched a new communications service for business aviation operators and the companies that support them. SAVCOM, which stands for Secure Aviation Communication, provides a platform allowing 256-bit end-to-end encrypted phone calls, and encrypted text, videoconferencing and file sharing on users' mobile devices as well as a desktop browser-based interface.

"We founded SAVCOM on the commonsense belief that business aviation operators, flying expensive equipment with VIPs and typically representing very large security-sensitive corporations, must communicate safely and securely at all times," said Martin Hamilton, CEO of the Bellevue, Washington, company.

Communication methods used every day by the general public, such as cellular voice, SMS text, email and free-to-the-public chat apps, are not secure. This is especially true of foreign telecom data and voice telephony services, and public Wi-Fi.

Some countries, including Russia and China, no longer allow visitors to establish a virtual private network (VPN) to securely send email or retrieve files remotely.

"There are billions of attempts made each day around the globe to steal data and do harm to regular people," Hamilton said. "Fortune 500 corporations and high-profile and high-net-worth individuals are specifically targeted. SAVCOM removes all these risk variables from the safety and security equation, and it can be used with any data system around the world."

SAVCOM maintains client security through a proprietary, closed, private network not available to — or accessible by — the general public. The system works with any domestic or foreign telecom data provider, internet service provider (ISP), public Wi-Fi or aircraft internet data system.

Clients can set up unique communications groups and one-way broadcasts, allowing organizations to rapidly disseminate information to the right people at the right time. SAVCOM also offers an encrypted audio-videoconferencing feature that gives users the ability to either schedule a videoconference or have an impromptu meeting with multiple personnel. There are no browser plug-ins, conference codes or dial-in numbers.

SAVCOM also offers potential applications for emergency response plan (ERP) providers and telemedical services, where the ability to rapidly assemble a team and communicate securely from multiple locations is key to responding quickly and effectively, and possibly saving lives. **BCA**

in-service Bombardier Challenger 350 jets, as well as on in-service Challenger 300s.

In August, Viasat's business aviation IFC system received STC approval from the FAA through Gulfstream Aerospace, certifying the use of its Ka-band system on the Gulfstream G650 and G650ER. When combined with its prior FAA STC for the Viasat Ku-band system, Gulfstream operators get a tail-mounted dual-band (Ka/Ku) service.

Business aviation has experienced market turbulence in the past and will likely do so again from time to time. It's just part of the environment. Meanwhile, keep in mind that inflight connectivity has been transformative, helping passengers stay productive and engaged while traveling.

Great connectivity relies on more than reliable high-speed networks and data systems. It requires the expertise of thousands of people who turn the capability into practical and meaningful activities. Let them know you need them. **BCA**

Persevere

"When you come to the end of your rope, tie a knot and hang on."
— Franklin D. Roosevelt

Ka-, Ku-, L-Band and SwiftBroadband for Dummies

These satcom services are three flourishing, competitive technologies used in IFC offerings to business aviation. But remembering which is which can sometimes be challenging to the unfamiliar, so here's a concise refresher:

▶ Ka-band operates in the 26.5-40 GHz radio frequency range.

▶ Ku-band operates in the 12-18 GHz radio frequency range.

▶ L-band mobile phones operate at 800-900 and 1700-2100 MHz. Iridium satellite phones use frequencies between 1616 and 1626.5 MHz to communicate with the satellites. Inmarsat and LightSquared terminals use frequencies between 1525 and 1646.5 MHz. Thuraya satellite phones use frequencies between 1525 and 1661 MHz.

▶ SwiftBroadband, using the Inmarsat satellite constellation, is a packet-switched communications network. It's considered good for email, web surfing, weather, flight planning and phone calls. Streaming video and audio typically require more bandwidth, although lower quality video can be streamed with high-gain systems. It provides data connection of up to 650 Kbps per channel for aircraft globally (except for polar regions). Designed to compete in the business aviation communications market, the service is shared with other users of the system. There are 200 spot beams per satellite, with each beam supporting up to 90 channels of 432 Kbps of streaming service for the aviation market, which provides a guaranteed bandwidth of 650 Kbps. It further supports four new streaming rates.

And so basically, the higher the frequency the more bandwidth you can send through the system — think of the difference between FM and AM broadcast radio.

In IFC, the Ka band allows higher bandwidth communication and is served by Inmarsat's Global Xpress Jet ConneX service. That service delivers data speeds capable of supporting video streaming, Voice over Internet Protocol (VoIP), live TV, file transfer and VPN.

Once primarily used for lower-speed satellite communications, most notably by direct broadcast satellites to broadcast satellite television and other specific applications, performance of Ku-band systems has improved in recent years with typical speeds now around 18 Mbps. Honeywell's Jet ConneX satellite communications service, for example, can achieve speeds of up to 33 Mbps, exceeding the speed of many ground-based Wi-Fi services.

Aircraft use L-band service for basic phone and data connectivity services, such as those provided by Satcom Direct via Iridium's Certus program. That service brings lower-cost options with smaller hardware and speeds initially of up to 704 Kbps and eventually up to 1.4 Mbps.

Meanwhile, using the Inmarsat satellite constellation, SwiftBroadband was designed to compete in the business aviation communications market. There are 200 spot beams per satellite, with each beam supporting up to 90 channels of 432 Kbps of streaming service, which provides a guaranteed bandwidth of 650 Kbps. It further supports four new streaming rates.

Given passenger expectations, most aircraft flying today are probably due for a connectivity upgrade. Even aircraft that rolled off the assembly line early in this decade are often equipped with only air-to-ground systems or low-speed voice and data capabilities. The best equipped operate on the Ku-band and probably connect with top speeds in the 3-4 Mbps range, too slow to satisfy most discriminating business aviation passengers.

Other factors affect the quality and speed of satcom services used by business aviation. A satellite's current location relative to an aircraft antenna's location can sometimes be a factor. Spot beams increase bandwidth in focused high-traffic regions. Both Ku and Ka can suffer from "rain fade" attenuation (Ka more than Ku), though not typically above FL 350. Bandwidth varies according to the specific application being used. Your mileage may vary. **BCA**

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Despite diverse challenges, **business aviation is coping**

BY **DAVID ESLER** david.esler@comcast.net

Of all international business aviation operations, 80% involve trips between North America and Europe. Despite mutual political rivalries, business flows uninterrupted in both directions across the Atlantic — certainly slowed by the COVID-19 pandemic but nonetheless intact and accessible by business jet.

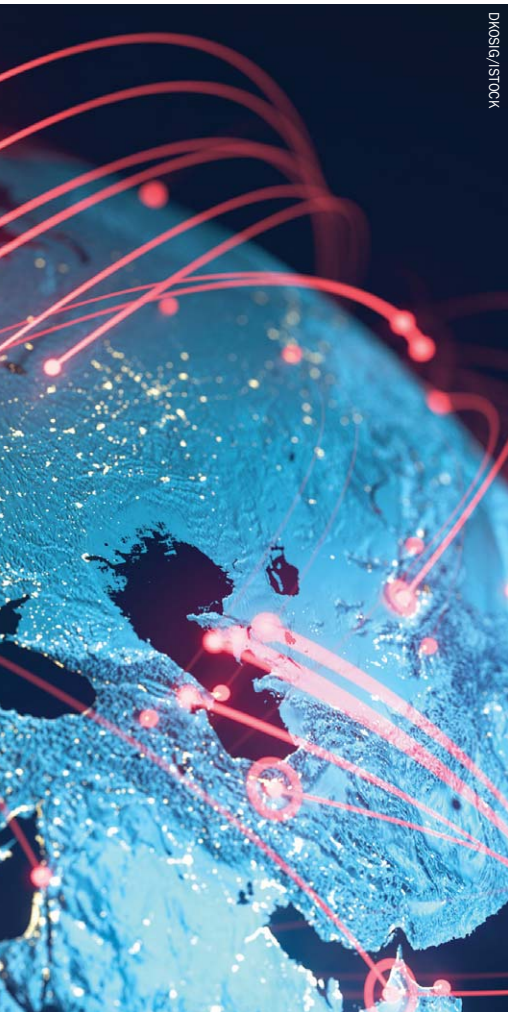
And while passenger airline traffic in the North Atlantic has declined 70%, in Europe this spring, the relative percentage of business aviation traffic tripled from its normal (pre-COVID) level. However, it was a different story from March through May during the early and worst stages of the pandemic. According to Athar Husain Khan, secretary general of the European Business Aviation Association (EBAA), business aviation was "hit pretty hard. We were tracking -55 to -60% of market presence compared to last year."

On the other hand, the Europeans also saw a recovery during the spring that was quicker and steeper than the airlines. "We were almost at a par in August, almost at the same levels as a year ago. Very recently — over the last couple weeks [in September] — we were seeing a slight deterioration, down to -16% compared to 2019. What we are seeing in Europe is a drop in the operations of the larger business jets. Lighter aircraft are probably in better shape. In general, compared with the airlines, the figures are a lot better but are still not where we want to be."

So the trend during the pandemic is that business aviation activity has increased as airline activity decreased. The only segment of commercial aviation that is thriving on the Continent is air freight, as the COVID-19 lockdowns have made European residents more dependent on web-based shopping for just about everything, and a lot of commodities are being delivered by air.

Business Aviation to the Rescue

One reason for the business aviation surge in Europe — just as in the U.S. — is humanitarian support: medical flights, repatriation, donor transportation, and delivering supplies like COVID-19 tests and personal protective equipment (PPE) to medical facilities during the pandemic. Such activity "normally accounts for 9 to10% of all business aviation in Europe but climbed to 25% at the height of the pandemic,"


DIKOSIS/ISTOCK

Khan said. He also confirmed some "new potential in people trying business aviation who haven't before." As a result, charter operators are receiving more queries than under normal circumstances.

In the European tourism and travel sectors, representing 22 million jobs depending on the country and its GDP, "there are some that are heavily dependent and some that are less," Khan observed. "And if you look at the range it is between 4.5% and 25%, depending on how reliant they are on travel and tourism — particularly the coastal countries in Southern Europe."

There are approximately 4,000 business aviation aircraft based in Europe: About one-third (1,300) are turboprops; light jets number about 1,000; midsize jets tally about 500; heavies account for another 1,000; and the "business liners" (converted airliners like the BBJ and A319CJ) tally 100 aircraft.

At the Brussels headquarters of the European Organization for the Safety of Air Navigation — or Eurocontrol — Ken Thomas witnessed "a tremendous drop" in traffic over Western Europe as the pandemic kicked in. "On April 22, the peak was 4,500 flights, or 15% of normal," Thomas, who heads the director's office of Eurocontrol's Network Manager Directorate, related to *BCA*. The agency's raison d'etre is massaging flow control for 41 member states in Europe plus two associates in Africa and the Middle East.

"At that time, the Network Manager began a recovery program, as we had to support the flights still operating, mostly cargo and business aviation, over the most efficient routes," Thomas, a Swede who began his career as a controller, explained. "The other thing we focused on was to be sure we had a grip on how traffic would recover to ensure sufficient capacity in the airspace and at airports. We could not afford the ATM network being a bottleneck for a recovery."

In response to the emergency, the Directorate activated the European Aviation Crisis Coordination Center and assembled a recovery cell that meets weekly consisting of the air navigation service providers (ANSPs) of the member states and representatives of airspace users and airports. "With them, we looked operationally at the resilience of capacity and stakeholder ATC centers," Thomas said. "We got the operators to approve a plan for four to six weeks out so we could plan ahead for more or less capacity." Less is important, too: what was needed and what could be kept in reserve. "We have around 50 people online at each meeting."

June 2020 peaked at 6,500 flights, and on Aug. 28, Eurocontrol enjoyed a peak day of 18,800, or 49% of the same day in 2019 when 37,000 flights were logged. "So we were seeing a partial recovery," Thomas said.

Differing COVID-19 Rules

During the pandemic, states maintain their own rules regarding which aircraft and passengers they allow across their borders. Just to make things interesting, these change every week, dependent on quarantines.

"Now the recovery has slowed down and retracted a bit due to the 'second wave' of infections sweeping across Europe," Thomas said. "There is reluctance among the traveling public to book trips, as they can't plan ahead due to quarantines being imposed in their countries. So, now we are seeing yet another reduction in traffic — now looking at peaks of 17,500 flights for October, which is down to 45% of normal. Ryan Air flies the most right now, 1,300 flights per day. Next is easyJet, followed by Turkish Airlines and Air France."

Guy Gribble, retired American Airlines captain and founder of the International Flight Resources procedures training company, elaborated on the unique and fluid restrictions European countries are imposing in response to the changing impacts of the pandemic. "Countries are coming up with various COVID restrictions," he said. "Approved countries can be entered without any test or quarantine — a 'white list' allowing free transit. A supplement to that is that some countries may require a 14-day quarantine.

"Some will not require the quarantine but will require a COVID test valid within the previous 72 hr. before entering," he continued. "The validity period is measured backward from the time you're standing in front of the quarantine officer. You will need documentation for the test; some may require an entry form with the test documentation stapled to it for passengers. However, 98% of these countries do not require this for crew if they are sequestered in the airport hotel where they can rest, eat and then leave." Note that this mostly applies to charter ops.

Eurocontrol is trying to see "that those who want to fly can do so," Thomas said. "In general, the delays across Europe are super small. So, there are no revised procedures [at Eurocontrol] but an ongoing commitment to zero delays." On Sept. 29, close to 15,000 flights were filed, less than half on the same day in 2019. Delays were running at 1,660 min. — 900 alone from weather at Istanbul — compared to 50,000 to 60,000 min. last year. "Other than the reductions," Thomas pointed out, "it is business as usual if you have the passengers, and that depends on the various restrictions that different countries are setting out for passengers and flights." To support more operations, as a daily service, Eurocontrol publishes a summary of COVID-related NOTAMs, "all in one place" at the Network Manager Operations Portal, which can be found on the Eurocontrol website at http://www.eurocontrol.int

What Arrivals Can Expect

"At EBAA at the onset of the pandemic," Khan said, "we established a resource center on our website [**http://www.ebaa.org**] that is updated regularly with lots of hands-on operational information on

curfews and operational restrictions. Have a good look at that if heading over." A key piece of information to know, Kahn emphasized, is to ensure that all passengers are "entitled" to enter Europe with respect to the pandemic and individual country restrictions. Note the requirement for masks and quarantines for specific countries. Operators should conduct this research before filing for any destination in Europe.

At the regulatory level, business aviation is confronted with a patchwork of conflicting restrictions, "so what the industry is doing," Khan reported, "is pushing hard at the European registry level for a harmonized approach: ANSPs, airports, business operators and airlines. This is directed at the highest levels in Europe, including the European Commission and the individual countries of the EU. It is difficult to do this, as many countries are of the opinion that health is a national competency, a prerogative of the national government, not the EU, and they don't coordinate."

A good source of information on flying into Europe during the pandemic is Ops Group (visit **https://ops.group/blog/europe-covid-travel-rules/**). Some points from a recent Ops Group posting:

▶ The U.S. is not included on the EU "safe list" of non-Euro countries from which the EU recommends allowing nonessential inbound travel. And it probably will not be added by the time this is published.

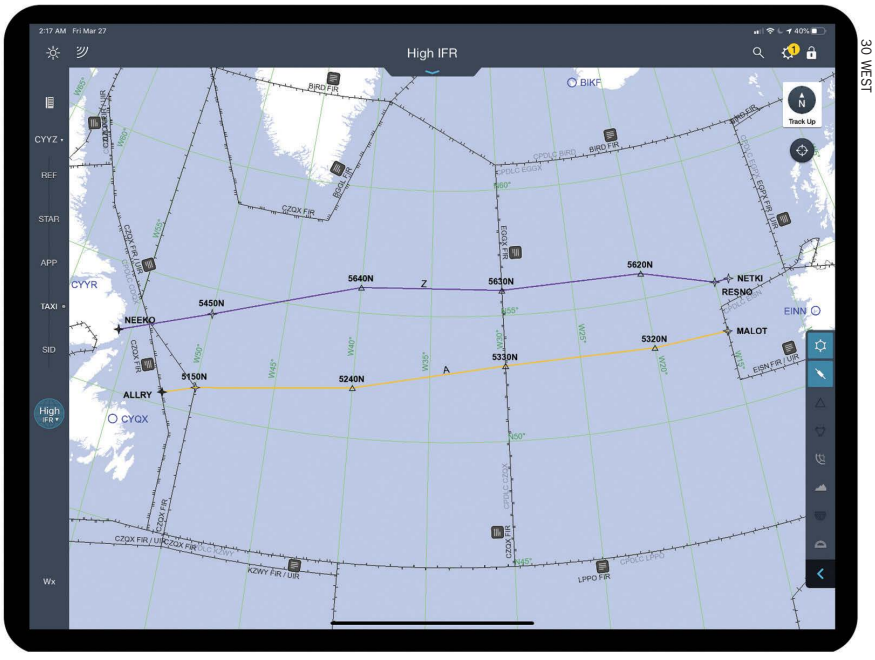
In early fall, the safe list included Australia, Canada, Republic of Georgia, Japan, New Zealand, Rwanda, South Korea, Thailand, Tunisia, Uruguay and the Schengen Associated States (i.e., non-EU members) of Switzerland, Iceland, Liechtenstein and Norway. China may be added to the list if it offers a reciprocal deal for EU travelers. As did Khan, Ops Group notes that there is considerable variation in the internal rules imposed by individual countries.

▶ Some Euro states only consider where you're flying from as opposed to the nationalities of passengers aboard the aircraft. (This is the opposite of the U.S., which is only concerned with where the passengers have been within the previous 14 days.)

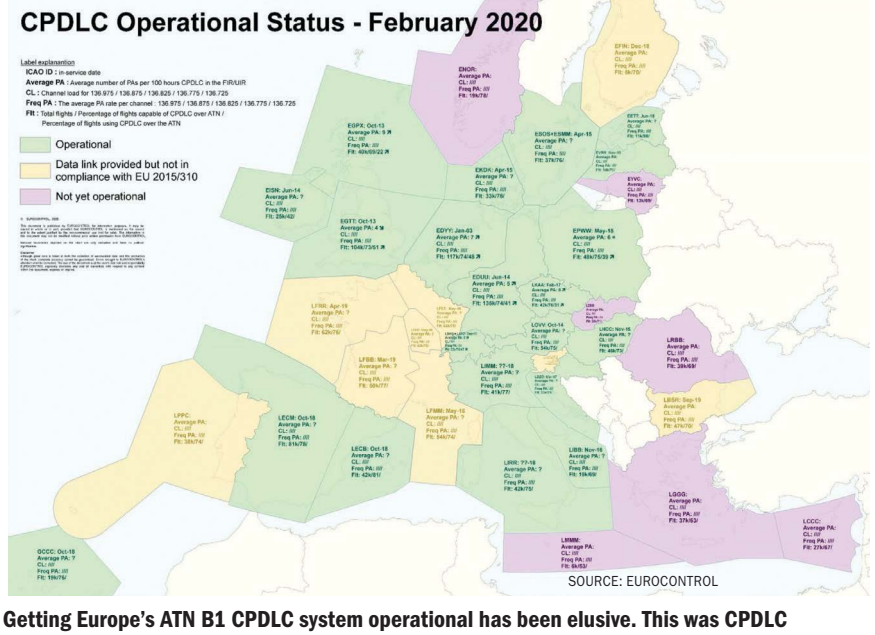
▶ Intra-Schengen freedom of movement is still largely in place, i.e., most Schengen countries are still open to entry from other Schengen countries, and here is the basis for one of Ops Group's famous workarounds: "If you can get into one, you're more likely to access others." (Hold that thought.)

▶ Where that doesn't work, many countries are still allowing direct flights from the U.S. under the caveat of "business purposes." As of mid-October, these countries included Austria, Belgium, Bosnia, Croatia, Denmark, Italy, Montenegro, the Netherlands, Serbia and Spain.

▶ Here's another Ops Group workaround, and it concerns getting into France, where, again as of mid-October, passengers flying from the U.S. directly to France could only do so for "essential" reasons, backed up by an "international travel certificate" (a form passengers need to fill out). But, according to Ops Group, "travelers from the U.S. can dodge this ban by flying to the U.K. first, do a quick stop there, get your passport stamped, and then fly straight on to France." This loophole works because the French rules are based on where the operator flies from, not the operator's nationality or where the flight originated. A quarantine is avoided with proof of a COVID-19 test and completion of a

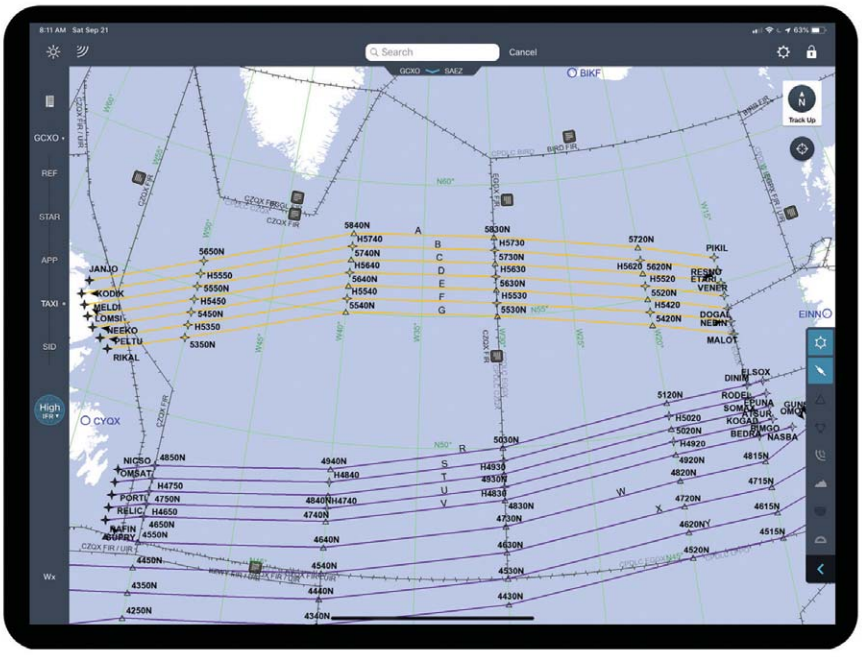


Plot of North Atlantic Track System (NATS) on Friday, Mar. 27, 2020, reflects impact of COVID-19 pandemic on aviation.



SOURCE: EUROCONTROL

Getting Europe's ATN B1 CPDLC system operational has been elusive. This was CPDLC status the month ATN B1 equipage was mandated. As of late October, six FIRs (*i.e.*, countries) had not turned it on, and the eight that have are not compliant technically.



Plot of the NATS on Sept. 21, 2019, a normal pre-COVID Saturday.

Public Health Passenger Locator Form. ▶ Italy is another story: Ops Group characterizes the entry rules there as "horribly complicated." While there are a few ways U.S. passengers can enter Italy, the most popular one is for "business purposes" — but in this case operators will need prior approval and an invitation letter from a local business. Maximum ground time allowed in-country is 120 hr., but no quarantine is required. ▶ Turkey reopened for passenger flights in June and with one exception is entertaining the most-liberal visitation policy of any country in Europe. That exception is Turkey's longtime foe, Greek Cyprus, from which no flights can enter Turkish airspace. Passenger flights originating in any other country are welcome. And as long as passengers are not exhibiting COVID-19 symptoms, quarantines are not imposed; however, health checks will be administered on arrival. The Turkish Directorate General for Civil Aviation (DGCA) has published guidance for operators on preparation for flights to the Anatolian Peninsula on the DGCA internet site at **http://web.shgm.gov.tr**

Operating in European Airspace

The EBAA's Kahn advises that once operators have educated themselves on the pandemic requirements for their destination countries, they file well in advance. "Make sure you have all the information available so Eurocontrol can manage the flow and the airports will know when you are coming in. Be aware of night curfews or evening or morning 'shoulder curfews' that might be imposed and limit your ability to get into airports at certain times. Do your homework. Most restrictions are noise-related, which is why there are so many curfews."

The EBAA and airspace users "do not have a discussion in Europe about privatization of ATC, as business aviation does in the U.S.," Khan revealed. "What we do have here is a fight, not just by business aviation, for more efficient ATM in Europe, as there is a general inefficiency in the system. In that sense, we are together with our colleagues in the airlines. It is not Eurocontrol that is the problem, it is the national ANSPs. The patchwork we live with exists because of nationalism; Eurocontrol is trying to facilitate flow across the Continent." These inefficiencies result in limited access to congested airports; all the large hubs are congested and, thus, slotted, which Khan believes is unfavorable to business operators.

But now, during the pandemic, a paradox has emerged: Due to the huge decrease in airline traffic, business operators have no problems getting into these airports "because there is no one else flying," Kahn noted, and "the airports are glad to have that traffic!" But as operations return to normal levels, it is expected that business aviation will again have a hard time gaining access to those facilities. "The worst ones are Heathrow, Paris CDG, Frankfurt, Amsterdam and others," Kahn continued. "Obviously, business aviation also flies regularly to regional airports that are less constrained, but most executive passengers want to fly to the hubs." The congestion depends on seasonality for some airports, especially those in southern Europe, but at the major hubs, it is year-round.

Early in the pandemic, a major mandate deadline came due that affects European air operations above FL 285. This is the requirement for the Aeronautical Telecommunications Network (or ATN B1), a VHF data-link system supporting Controller-Pilot Data Link Communications (CPDLC) in domestic (i.e., non-oceanic) airspace, the deadline for which became effective on Feb. 5, 2020, after being rescheduled several times since 2018.

In Europe, ATN has long been held out as one of the foundational pieces of the Single European Sky ATM Research (SESAR) modernization program (comparable to the FAA's NextGen). At its most basic, ATN B1 is texting as an adjunct to (and eventually a replacement for) voice communications. The beauty of it — and right now a hopefully fixable disadvantage — is that it operates off of the existing cellphone tower grids supporting mobile telephones.

Get Ready for Data Link

Operators need be aware that now — with exceptions we'll get to further on — aircraft expecting to cruise above FL 285 in Eurocontrol-managed airspace must be equipped with ATN B1 avionics and their crews trained to use it. It is also important to understand the difference between ATN, which operates CPDLC through a ground-based VHF telecommunications network, and FANS 1/A, the oceanic surveillance and comm data-link system that bounces its text messages off communications satellites in geostationary orbits 25,000 sm above the earth. This means that (again, with exceptions) if an airplane is equipped only with FANS avionics, it will not be able to access ATN B1, since the latter is not compatible with FANS and also uses a different messaging protocol. So equipage, especially in older business aviation airframes, could be an issue for some operators.

While the intentions behind domestic CPDLC might have been a good idea in the pre-COVID era when traffic was predicted to increase exponentially and data-link comm was seen as an efficiency expediter, establishing the ATN B1 network has been challenging in the patchwork of states that forms the EU. Even with the deadline in effect, the continuity of the system is

inconsistent across the Union.

As Khan sees it, "We are experiencing a lot of implementation issues with the CPDLC mandate. The first deadline was 2018, but the system is still not fully deployed by the individual EU member nations, which is frustrating to operators that have equipped."

As of this fall, the status of the 41 Continental member states of Eurocontrol fell into three categories: fully implemented, not implemented and not in compliance. According to Eurocontrol's Thomas, at that time, 75.5% of airspace users were ATN B1-capable with 18% exempt (again, explained later). "The remaining 6.5% were not compliant according to flight plans," Thomas said, "but a third would probably be exempt if they filled out the flight plan correctly. There are still some avionics issues, as it needs to be installed in the aircraft, so it's an issue for business aviation." The Eurocontrol center at Maastricht has become "really reliant" on ATN, Thomas claimed. "Thus, we are supporting the technology."

But there have been technical issues with ATN B1. "Originally, it was carried on a single frequency," Mitch Lanius of 30 West International Procedures noted. "It quickly became evident that multiple frequencies were needed, and EASA kept changing the tech standards." That meant that anyone who equipped early did not meet the tech standard du jour. "Six FIRs have not turned it on; eight have but are not compliant technically. One problem with it is that it gets interference from adjacent frequencies that makes it drop messages." Gribble added, "They are running out of bandwidth in the cell towers. Messages have a 60-sec. lifespan for replying; if not answered, the message aborts."

Because of this, Lanius said, "The FAA abandoned it early as unsuitable." In its design for NextGen, the FAA had considered a similar VHF-based domestic data-link comm network dubbed PM-CPDLC (for "protected mode").

Now, for the aforementioned exceptions. First, aircraft equipped only with FANS 1/A avionics can use that equipment for data-link comm in U.K. airspace and when being worked by Eurocontrol's Maastricht Center. "Anywhere else," Gribble said, "it will be ATN B1 or nothing but voice."

Second, for operators who have not equipped their aircraft with ATN B1, there is an exemption under Paragraph (d) of EU Commission Implementing Regulation EU2019/1170 for aircraft with 19 or fewer seats and MTOWs less than 100,000 lb. (45,359 kg). According to Lanius, "The only business aviation aircraft that should not comply for this exemption is the Gulfstream 650ER, which exceeds 100,000 lb. at takeoff." And of course, business jet liners like the BBJ and A319CJ.

This is obviously a concession to business aviation, given that the exemption covers most aircraft types operated in this segment by corporations, wealthy individuals, state governments or charter companies. But the handwriting is on the wall (or implicit in the regulations) that eventually Eurocontrol and EASA are going to want everybody on the same page (including the ANSPs that have yet to implement their ATNs). This is to say, those capable of conducting data-link comm when in European airspace. So, operators with plans to use that on a frequent basis should consider equipping with ATN B1 avionics.

In the meantime, Eurocontrol's Thomas advises that "an aircraft that wants to fly at or above FL 285 in the European airspace covered by the Data Link Service Implementing Rule should indicate in the flight plan either equipage capability — enter 'J1' in field 10a — or that the aircraft is exempted — 'CPDLCX' in field 18. Today, even if neither is indicated, the flight plan will not be rejected at Eurocontrol Network Manager-level; however, plans to introduce an enforcement of the rule are 'well advanced.'"

(France), and Skyguide (Switzerland) — have instituted the "Logon List" (formerly the "White List") identifying certain business aviation aircraft types and ATN B1 avionics configurations by serial numbers and production blocks that are prohibited from logging onto the CPDLC networks due to previous high rates of failure. (Whether this is a problem with the avionics sets or the ground networks is unclear.) Aircraft on the Logon List, if covered by the previously described exemptions, may still operate above FL 285 but will be restricted to communicating with ATC via VHF voice. For more information on the Logon List, readers are advised to consult **https://ext.eurocontrol.int/WikiLink/index.php/Logon_List**.

Now, understand, these are the aircraft that are equipped to operate in ATN B1 airspace but which mess up the CPDLC networks. Go figure . . . but, hey, it's 2020. **BCA**

ATN B1 Equipage

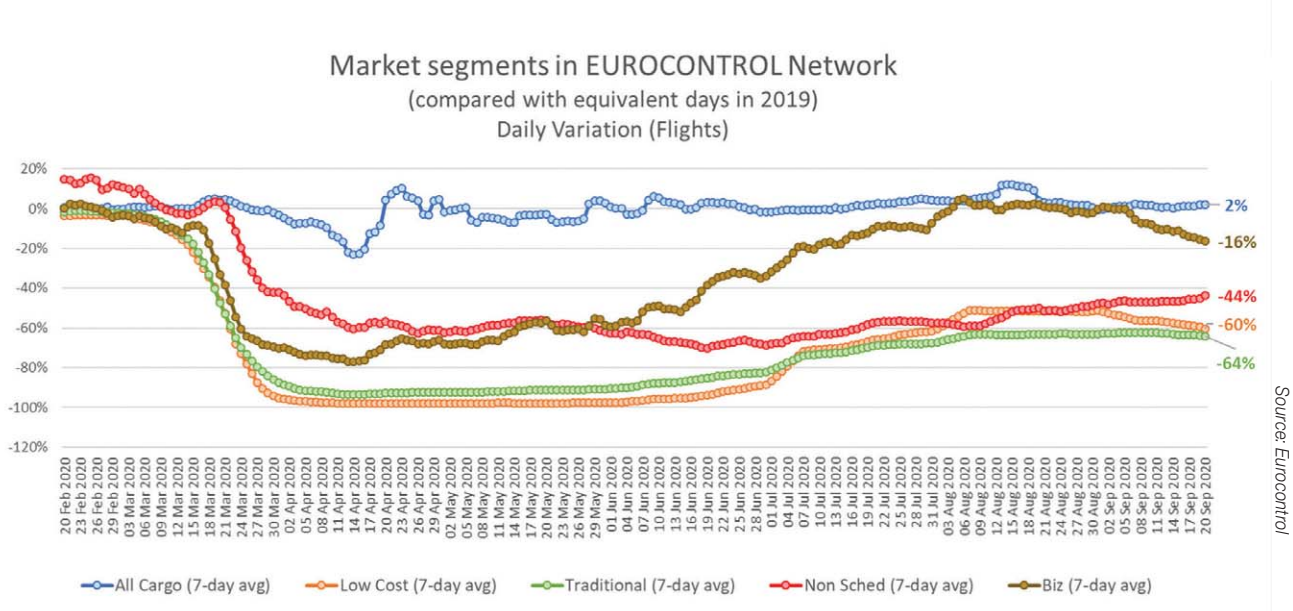
We asked our business aviation brain trust of corporate and charter pilots if their operations had committed to installing their aircraft with ATN B1 CPDLC avionics. Three of them responded, and all frequently operate in European airspace.

▶ Gary Dietz is chief pilot for a major U.S. corporation's flight department that has equipped its fleet of large, long-range business jets with ATN B1 avionics. "Bottom line," he said, "we spent the money for the upgrade because we did not want to be excluded from European airspace. Plus, it's good for resale value. You may not get the full dollar return, but you are not being eliminated for not having it when a potential buyer is looking."

▶ Nat Iyengar, a Gulfstream G650 captain at Jet Aviation-Hong Kong, points out that "The G650 fleet is split in two — aircraft serial number 6310 and subsequent. The newer aircraft [6310 and subsequent] are qualified for PM-CPDLC via VHF VDL Mode 2 [*i.e.*, ATN B1]. The other aircraft are grandfathered in for now and will be compliant after the next software Block-3 update in 2021 Q2."

▶ Mark McIntyre, a Gulfstream captain at Mente LLC, added that "G650/G650ERs s.n. 6310 and subsequent that comply with Aircraft Service Change [ASC] 039A meet the Eurocontrol equipage [hardware] requirements. However, for certain Eurocontrol airspace, compliant operators are not allowed to use their ATN B1/PM-CPDLC capability due to performance issues. PlaneView Avionics Block 3 [ASC 903] is expected to resolve the performance issues.

"Our international procedures resource has suggested that within Eurocontrol airspace, we attempt an ATN B1 logon. If it's accepted, great. If it's rejected, no harm, no foul. Full disclosure: This is technique, not policy." **BCA**



Source: Eurocontrol

From February to September 2020, the most consistent use of Eurocontrol airspace was by air cargo and business aviation.

The 'Shaming' of Aviation

Aviation has been in the sights of environmental activists for some time and particularly in Europe, where aviation has become a target for "shaming" as a source of atmospheric pollution. BCA asked EBAA Secretary General Athar Husain Khan to comment on what role the European business aviation advocacy group is taking in this conversation. His response follows.

"First, let's talk about sustainable aviation fuels [SAF]. The Business Aviation Sustainable Aviation Fuel Coalition [BASAFC] was formed by the EBAA, NBAA, GAMA, IBAC and NATA more than a decade ago because we believe sustainable aviation fuel is one of the key components for reducing our carbon footprint and increasing our sustainability impact. We are heavily committed to this as an industry and have published the Business Aviation Commitment to Climate Change pamphlet, setting out three goals and a pathway to reduce our carbon footprint as an industry. One of those goals is an improvement in technology, which is not only design of engines and aircraft but flying on sustainable fuel.

"We had a showcase at Van Nuys [California] about 18 months ago with a lot of media presence; we also did another one at Farnborough 2018, as well as at the EBACE and NBAA conventions. We partnered with the World Economic Forum at Davos last year and made sustainable fuel available to operators flying into the meetings. We've published a guide with all the essential information for operators, suppliers and OEMs for SAF, including technical specifications. In addition to these associations, there were a lot of industry players involved, too: operators, refiners and manufacturers. CAAFI [the Commercial Aviation Alternative Fuels Initiative] recently joined the SAF Coalition, as well."

Be Proactive

"According to the [U.N.'s] International Panel on Climate Change," Khan continued, "worldwide aviation accounts for 2 to 3% of CO2 emissions; of that segment, 2% is business aviation. But we are aware that we have a footprint, and we need to address that any way we can — that is our argument and my personal take on aviation's impact on climate change.

"A more-efficient air traffic management system would decrease the carbon footprint of the aviation industry in Europe about 10% because of more-efficient direct routing and more-efficient flight levels compared to today's inefficient ATM system. This is one of the reasons why we are arguing with the regulators — if we save fuel by burning less of it, that is good for the environment.

"Our position on 'shaming' aviation at EBAA is, rather than being defensive, to turn the argument around and show how we are being responsible in terms of supporting the use of sustainable fuels and investing in more-efficient aircraft and engines, lighter materials, electrification of aircraft, and fighting for more efficiency in ATM. We believe that being proactive is a more-useful approach than defending our small contribution to emissions. And it is gaining traction." **BCA**

Aerion AS2

A $5 billion supersonic saga

BY **FRED GEORGE** fred.george@informa.com

It's the history of aviation. Go faster, higher, farther. So, imagine a world, a decade or more from now, when people can fly between most business destinations in 3 hr. or less. Leave New York at dawn, arrive in London in time for lunch, depart after 6 hr. of meetings and fly back to the U.S. East Coast for dinner with the family and help with the kids' homework.

The transpacific trips take a little longer. Flying times from New York to Tokyo, Beijing and Singapore will require, respectively, 3.5, 3.6 and 5.0 hr. Westbound, travelers can leave after a late dinner and arrive home before brunch because of the time-zone changes.

Such thinking is emblematic of business tycoon and philanthropist Robert Bass of Fort Worth. *"Audaces fortuna iuvat,"* Latin for "fortune favors the bold," could be his motto, as he took a $2.4 million inheritance and turned it into $5 billion through investments and partnerships in a wide array of industries. He's a long-term business aviation advocate, having owned several subsonic jets, and in 2003, he made an audacious bet that business travelers would want to fly at double the speed of then-current-generation aircraft.

Bass learned of Dr. Richard Tracy, an aerodynamicist whose extensive research on high-speed aircraft design led to a series of patents, and who in 1991 created the ASSET program, short for affordable supersonic executive transport. He was intrigued at the prospect of bringing a Mach 1.6 supersonic business jet (SSBJ) to market that could cut as much as 3 hr. off trip times between Europe and North America. The ASSET SSBJ would cruise twice as fast as the Mach 0.80 large-cabin aircraft of the day.

So, Bass formed an investment firm, bought Tracy's ASSET Group and formed Aerion Supersonic in Reno, Nevada. The aircraft would be priced at $80 million, about twice the cost of the day's average large-cabin, long-range business jet.

While not as swift as the Anglo/French Concorde, the ASSET SSBJ's speed advantage over subsonic aircraft could slash more than 3 hr. off transatlantic trips. Maximum range would be more than 4,000 nm, sufficient to fly from New York City to São Paulo, Paris to Washington, D.C., or Rome to New York. The ASSET SSBJ would also consume one-fifth the fuel of the Concorde on such trips, due to its considerably smaller size and weight, advanced aerodynamics and twin-engine design.

Only months after Bass formed Aerion Supersonic, the Concorde made its final flight. The 100-passenger supersonic transport proved to be a technological marvel during its 27 years in operation, but never a commercial success; only 14 were put into passenger service. Without hefty government subsidies from the U.K. and France, the Concorde's operating economics would have grounded it long before 2003. Its bottom line was its downfall. But operating expense wouldn't necessarily discount the value of an SSBJ.

Notably, there's a far different time and money equation in business aviation than in for-profit airlining. "[It] is the value of time . . . [that's leading] to increased interest in the feasibility of small supersonic civil aircraft," wrote Pres Henne, then Gulfstream's senior vice president, programs, engineering

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and test, now retired, in the May/June 2005 issue of *Journal of Aircraft*. Business travelers are willing to pay a price premium to save time. This was demonstrated when the long-range Gulfstream G650 was introduced. Its 30- to 35-kt. speed advantage over slower jets earned its manufacturer 400+ orders.

As for the prospects of a supersonic business jet, Henne wrote, "Once the concept has been proven on a small scale for the more affluent, then technical advances and commercial competition have typically led to larger-scale vehicles that appeal to a broader segment of the population." An entry-level supersonic business jet carrying eight to 12 passengers had the potential to reignite development of larger civil supersonic aircraft.

Other, more-recent studies reinforce Henne's conclusions. "The U.S. is experiencing a resurgent interest in civilian supersonic flight," according to research performed by the Institute for Defense Analyses (IDA), a non-profit think tank in Washington, D.C. The IDA's research study was commissioned by the White House Office of Science and Technology Policy in November 2018 to determine if, how and when the federal government might support civil supersonic flight.

The renewed interest is being fueled by 50 years of advances in engines, materials, design tools and flight control technologies that hold promise to make supersonic flight far safer, more efficient, more economical and more practical than it was when the Concorde and Russian Tupolev Tu-144 supersonic transports were designed, according to the IDA.

In part as a result of the IDA's report, the FAA issued a Notice of Proposed Rulemaking (NPRM) in mid-2020 that floats the idea of incorporating new supersonic aircraft, certified to be operated at Mach 1.8 or below and with MTOWs of 150,000 lb. or less, into revised FAR Part 36 noise standards.

The IDA makes reference to the Diffusion of Innovations principles advanced by Everett Rogers, an eminent American communication theorist and sociologist. These hold that once about one in 40 people embrace a concept or technology, it starts to overcome market inertia and achieve widespread acceptance by "early adopters," a term he created. The 2.5% so-called innovators will pay a price premium to gain access to the latest technologies. Tesla automobiles, iPhones and LCD big screen TVs all were made popular by early adopters who paid top dollar at the time these breakthrough inventions came to market. Newer derivatives typically are bigger, more capable and less expensive.

Climatic Challenges, Opposition

Electric cars, cellphones and giant-screen televisions, though, don't have the high-profile, atmospheric influence and thus controversy of supersonic aircraft. The IDA report cautions that "[d]espite anticipated technical advancements, the physical realities of flight in this regime are such that supersonic aircraft are still likely to have a greater environmental impact [in terms of noise and emissions] than their subsonic counterparts."

There's considerably more pressure to "go green" today than when the Concorde made its debut. When environmental activist Richard Wiggs founded the Anti-Concorde Project in 1966, he had few followers. Now, the "flight shaming" movement, started in Sweden, has strong following around the planet and new supersonic aircraft will become prime targets. In August 2020, a consortium of 62 climate change, environmental and public health organizations, including the Center for Biological Diversity (CBD), Natural Resources Defense Council and Earthjustice, blasted the FAA's plan to revive supersonic aircraft.

"The Trump administration's plan to revive these super-polluting planes is a huge threat to our climate and the air we breathe," says Clare Lakewood, legal director at the CBD's Climate Law Institute, a non-profit group with 1.7 million members. "We need rules that protect our air and climate from aviation pollution, not ill-conceived efforts to revive a particularly dirty form of transportation," she says, citing a 2019 study by the International Council on Clean Transportation that claims a new fleet of SSTs would emit more than 100 million tons of carbon emissions each year.

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Typical floor plan will have two seating areas. Cabin cross section is super-midsize in the rear, tapering the midsize cross section up front. Most trips will be 3 hr. or less, affording time to stretch out after you've reached your destination.

Pressure from environmentalists doubtlessly will accelerate the aviation community's transition from fossil fuels to synthetic fuels, either derived from plant or algae biomass feedstocks or by combining carbon dioxide harvested from the atmosphere with hydrogen. The goal is to make aviation carbon neutral by 2050.

However, even using 100% carbon-neutral fuel, supersonic aircraft will burn considerably more of it and create proportionately more water vapor as a byproduct of that combustion. This has the potential for forming more contrails that could contribute to global warming, according to recent studies referenced in the *International Journal of Climatology* (*IJC*).

"The artificial cloudiness generated by contrail outbreaks alters the

atmospheric radiation budget, potentially impacting the surface air temperature, particularly the diurnal temperature range (DTR), or difference between daytime maximum and nighttime minimum temperatures," wrote Jase Bernhardt and Andrew Carleton in a March 2015 *IJC* report.

Environmental concerns notwithstanding, a renewed focus on supersonic airplanes is likely to bring attention to ground travel times between office or home and the airport as well. After all, what's the net benefit in reducing the flight time from New York to London to 3 hr. if you spend 1.5 hr. at each end in a taxi? Should Aerion or other supersonic business jets actually enter service, they are likely to boost point-to-point urban air mobility (UAM) vehicles, a segment now drawing considerable investment and technological development, because they hold the promise of slashing travel times between launch points and airports by 80%, or more.

Environmental, political, financial and other challenges aside, market studies by Gulfstream, Meridian, Teal Group and Rolland Vincent Associates, among others, indicate there will be market demand for 200 to 500 small supersonic aircraft over the next 20 years.

With today's technologies, there are no showstoppers to building and certificating a viable supersonic business jet. The real challenge is finding ways to satisfy all the present-day competing needs and concerns, ones that have changed greatly in the past two decades. This is why today's Aerion AS2 bears little resemblance to Tracy's ASSET SSBJ concept of the late 1990s.

Learning From History

"Malum consilium quod mutari non potest," roughly translated from Latin as "bad is the plan that cannot change," is another apt descriptor for development of the Aerion AS2. The original plan was to build a lean, twin-engine aircraft with 4,000+ nm of range.

During the past two decades, the aircraft has been through at least a half dozen major design iterations, now making it a considerably more mature design with attainable performance targets. It's also one of the longest-running aircraft development programs in the history of business aviation, so it's useful to look at its history.

When Bass started to invest millions of his own dollars in Aerion, he hired Brian Barents, a well-respected veteran executive with successes at Cessna, Learjet and Galaxy Aerospace, and charged him with advancing the aircraft to market. Bass' plan was to mature the technology, line up risk-sharing partners and team with a major general aviation airframe manufacturer for final design, development, certification and production. Board members included Bass as chairman, Barents as vice chairman, Tracy as chief technology officer, Michael Henderson, the former program manager for Boeing's high-speed civil transport program, as COO and Robert Morse, a partner at Bass' Oak Hill Capital.

For the first three years, Aerion quietly conducted market research, accomplished preliminary design work and gauged vendor interest. The program was formally unveiled at the October 2004 NBAA annual convention. Detailed design work was scheduled to begin in 2005. Once all risk-sharing partners were aboard, Aerion planned for a five-year development program. Entry into service was slated for 2011.

Tracy's ASSET SSBJ was a low-risk design, the aircraft to be constructed from conventional materials and using proven systems. He chose aluminum alloys for the fuselage and carbon-fiber reinforced composites for the wings. It was to have a 17-ft.-long, two-section main cabin with a 5-ft.-long galley up front. The aft cabin would have had a super-midsize cross-section aft, tapering to a midsize cross-section up front, affording seating for eight passengers, 12 people in a pinch if the galley was converted into a seating area. The svelte, but 145-ft.-long ship was intended to have per-mile operating costs that would be competitive with large-cabin business aircraft having similar 4,000+ nm range, such as the Bombardier Challenger 604, Dassault Falcon 900C and Gulfstream GIV-SP.

Two critical enabling technologies would make possible the Aerion SSBJ. First, Tracy capitalized on his 1964 Ph.D. from Caltech in hypersonic aerodynamics to design a revolutionary supersonic laminar flow, trapezoidal shaped, 1,400-sq.-ft. wing that would improve lift-to-drag performance by 20% over older, highly swept delta wings, such as that used on the Concorde. A scale section of his wing was tested on an F-15 at up to Mach 2 to prove its efficacy.

Second, the Aerion SSBJ would piggyback on an improved version of the popular and proven low-bypass JT8D turbofan engine. Pratt & Whitney was developing a JT8D-219 upgraded turbofan for re-engining the U.S. Air Force's fleet of Boeing 707s modified as E-8 J-STARS (Joint Surveillance Target Attack Radar System) aircraft that would have considerably higher temperature margins. This allowed for a 3,000-hr. TBO for the -219s intended for the Aerion.

Aerion hired Rolland "Rollie" Vincent in 2004 to conduct worldwide market research as to the viability of the initial concept. More than 100 business aircraft operators were interviewed and presented with a variety of designs. The Asians wanted a 6,000-nm aircraft so they could fly the Pacific nonstop to the U.S. The Europeans supported a 5,000-nm aircraft for missions to most major U.S. cities, including ones on the West Coast. U.S. operators wanted at least 4,500 nm of range. Virtually all who participated in the survey said they wanted a larger cabin, an improvement later incorporated into the design. They also insisted on incorporating an integral airstair for the main entry door and high flow rate, single-point pressure refueling capability for quick ground turns.

By mid-2007, Aerion was still searching for risk-sharing partners at the Paris Air Show. Program cost had ballooned to $2 billion and the projected entry-into-service date slipped to 2013. The revised plan, however, was snuffed by the 2008 Great Recession, as potential program partners pulled in their reins and attempted to survive the extreme economic turbulence. Skies became even stormier in 2011 when the J-STARS re-engining program was canceled. This effectively killed Pratt & Whitney's development of the upgraded -219 turbofan, leaving Aerion in search of a suitable engine to serve in its place.

Undaunted, Bass continued to support the program, ultimately leading to the second-generation AS2, a trijet design announced in May 2014. MTOW was bumped from 90,000 lb. to 121,000 lb. and fuel capacity increased from 45,400 lb. to 62,000 lb. Range was increased to 4,750 nm at Mach 1.4 and 5,300 nm at Mach 0.95. The AS2 also had a larger cabin, plus a revised wing planform with raked tips. Overall length was increased from 145 ft. to 170 ft., nearly 60 ft. longer than a BBJ. The AS2's unprecedented tip-to-tail distance was bound to create ground-handling challenges at general aviation airports, particularly on congested FBO ramps. The price soared to above $100 million.

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Gone is Dr. Richard Tracy's trapezoidal-shaped, supersonic laminar flow airfoil. Aerion and Boeing created a clean-screen cranked arrow wing that has the best overall lift-to-drag characteristics of any supersonic airfoil, says Chairman Tom Vice.

Aerion's fortunes appeared to reverse in September 2014, when Airbus' Defense and Space unit agreed to collaborate on AS2 development and industrialization. Airbus was keenly interested in Tracy's supersonic laminar flow wing technology, even though the French consortium wasn't interested in building a next-generation supersonic transport. Toulouse engineers believed Tracy's revolutionary airfoil might open the door for a new generation of jetliners that would cruise at Mach 0.95 to Mach 0.99 on less fuel than conventional airliners at Mach 0.785.

Bass called the collaboration "a major step forward." With Airbus' support, Aerion then targeted 2019 for first flight of the AS2 and certification in 2021. Aerion officials claimed Airbus' support "decisively kicks the program into high gear." Company officials conceded that $4 billion would be needed to bring the aircraft to market.

Aerion opened its order book in June 2015, pricing the aircraft at $120 million, and at the November 2015 NBAA Convention, Kenn Ricci, chairman of Direction Aviation Capital, announced an order of 20 AS2 SSBJs to be placed in service with the firm's Flexjet fractional ownership unit, thereby becoming the first fleet customer. However, Aerion acknowledged that first flight of the AS2 again had slipped to 2021 with entry into service in 2023.

Little more than three years into the joint venture, Airbus bowed out. Lockheed Martin was enlisted in December 2017. Lockheed/Lockheed Martin had extensive experience building supersonic military aircraft, including the F-104 Starfighter, SR-71 Blackbird and F-22 Raptor. But as one former advisor to Aerion notes, Lockheed's success in building commercially successful civil transports has been checkered at best during its entire history.

Hyperspeed Leap for AS2

Aerion underwent a step change in March 2018. Barents, with Bass' blessing, recruited Thomas Vice, then recently retired as president of Northrop Grumman's Aerospace Systems unit, to join Aerion as president and COO. Vice left Northrop Grumman in 2017 when it became apparent that Kathy Warden, not he, would be tapped to lead the company. After 31 years with the company, it was a bitter disappointment.

Vice left with a multi-million-dollar severance package, but while he was financially set for life, he wasn't finished with his engineering career. He "wanted to work on the next big revolution," he posted on his LinkedIn page, noting he "joined Aerion to revolutionize global mobility." He added that he's "always had a passion for engineering and fast machines." In August 2018, Aerion Corp. appointed Vice as chairman, president and CEO. Bass and Barents both left the board.

Under Vice's leadership, the AS2 program was about to undergo a major makeover. He enticed Boeing to become a venture partner in early 2019, knowing that then-Boeing CEO and President Dennis Muilenburg was keenly interested in civil supersonic aircraft. Boeing engineers continued to study supersonic transport designs well after the company's Mach 3 Boeing 2707 was canceled in 1971. In return for its investment, Boeing succeeded Lockheed Martin and landed two director positions — Mike Sinnett, Boeing's vice president of product strategy and future airplane programs, and Ken Shaw, vice president of supply chain at Boeing Global Services.

Aerion and Boeing almost immediately shelved Tracy's supersonic natural laminar-flow wing design, concluding that while it reduced wave drag by 20% at high speed, it wasn't the best solution for subsonic and transonic "boomless cruise" speeds. The team decided on a cranked arrow wing design, one that provides a better balance of performance and drag characteristics. "Laminar flow does have a significant benefit, if you're only going after [shock] wave drag," Vice said. "But the new cranked arrow wing has the best lift-to-drag performance of any [supersonic] wing I've seen. It has almost all the benefits of a variable geometry wing, but without the weight penalty."

The cranked arrow airfoil was developed using a new set of 3-D computational fluid dynamics (CFD) design tools that Aerion created in house. "We had to solve optimization of the wing because we couldn't find the design tools out there," Vice explained. "Now, we have so much data that we had to bring machine learning into the optimization tool set."

Other major changes include putting the wing-mounted engines into underslung nacelles with cylindrical inlets and exhaust nozzles, adding variable geometry to both ends. (See "GE Affinity Turbofans to Power AS2" sidebar.)

Today's version is expected to be half again as heavy as Tracy's original ASSET design, have a third engine, fly farther and have a more comfortable cabin. Major changes include wing shape and aerodynamics, choice of engines, nacelle and fuselage loft contours, as well as cabin cross-section. As of mid-2020, all of the major suppliers

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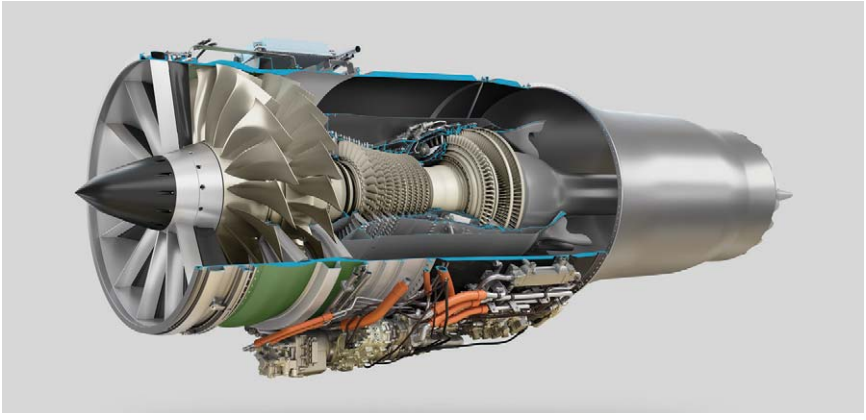

GE's adapting the nine stage compressor from the CFM56 and upgrading it with thermal barrier coatings for durability. Core pressure ratio should be close to 10:1. A clean-sheet, two-stage fan will provide about 3:1 bypass ratio and 2:1 pressure ratio, providing an overall pressure ratio of 20:1.

were on board and are all top-tier aerospace firms, including GE Aviation for engines and electrical power distribution, Honeywell for avionics, BAE Systems for digital flight controls, Collins Aerospace for actuators and Safran for landing gear, brakes and nacelles.

Two ground-test articles are planned and five fully conforming flight-test aircraft will be used in the certification program. Aerion plans to break ground on a new headquarters facility, complete with flight test center and manufacturing plant, in Melbourne, Florida, by year's end. In short, the AS2 is far closer to becoming a reality.

Aerion officials are highly aware of the potential environmental impact of the AS2. Accordingly, they've committed to making the aircraft carbon neutral from its first flight. It will be constructed from renewable, sustainable materials wherever possible. Its new Aerion Park campus in Florida will be powered by "clean energy" and have the goal of emitting zero waste. The airframe, systems and engines are being designed to use synthetic fuel, but the aircraft will also be able to use fossil fuel, if needed. Vice says Aerion intends to plant 100 million trees by 2036 to offset the total emissions of 300 AS2 SSBJs in operation.

Maturing of the design has caused Aerion to rein in some performance goals. Vice now predicts that the AS2 will fly 4,200 nm at Mach 1.4, 5,400 nm at Mach 0.95 and 3,500 nm at "Boomless Cruise" Mach 1.1 to 1.2 cutoff speeds, where its shockwave dissipates before reaching the ground. Mach cutoff banks on an atmospheric phenomena called the "caustic layer," a relatively low altitude level at which mild shockwaves are refracted into dozens of small shocks that deliver no perceptible noise on the ground. The big

GE Affinity Turbofans to Power AS2

GE Aviation and Aerion jointly are developing the first engine in more than half a century to power a civil supersonic aircraft. GE's 20,000-lb.-thrust-class Affinity is a low-risk design that uses a high-pressure core adapted from the CFM56 jetliner turbofan and GE F101/F110 military engines, upgraded with thermal barrier coatings and other improvements to assure reliable, prolonged operation at supersonic speeds up to Mach 1.6 and up to a 60,000-ft. operating altitude. The core features a nine-stage axial-flow compressor powered by a single-stage high-pressure turbine with a pressure ratio close to 10:1.

The core will be mated to a new two-stage, medium-bypass fan powered by a two-stage low-pressure turbine. The bypass ratio will be the highest ever for a supersonic engine at close to 3:1. However, it will be lower than for today's subsonic business aircraft, most of which are powered by turbofans with 4:1 to 6:1 bypass ratios that produce comparatively modest pressure ratios for low noise and best fuel efficiency. The Affinity's fan bypass ratio should be nearly 2:1, thereby boosting the overall pressure ratio to 20:1, almost ideally matched to the AS2's Mach 1.4 top cruise speed. The Affinity will produce sufficient thrust for supersonic flight without the need for an afterburner.

GE and Aerion both have committed to the AS2's meeting FAA Stage 5/ICAO Chapter 14 noise standards and that will be quite challenging, considering the Affinity's relatively low fan bypass ratio and high fan pressure ratio. Ken Shimabukuro, one of the aviation industry's most-experienced engine integration experts, offers some ideas on how this might be accomplished, as shown in the accompanying three-part illustration.

Shimabukuro would enclose the engine in a nacelle having a forward, translating exterior cowl inlet and an aft, translating exterior exhaust shroud. The center inlet spike and aft exhaust plug would remain in fixed positions to decrease installation complexity and increase operational reliability.

As shown in the top illustration, the positions of the cowl inlet and exhaust shroud would be moved fully open to provide high mass flow through the engine inlet and to allow secondary air to mix with exhaust gases, thereby adding mass and slowing exhaust flows much the same as a hush kit. Slowing the exhaust flow quiets the engine. A thrust cut-back procedure also may be required to meet Stage 5 takeoff, sideline and approach standards.

Once the aircraft has climbed well above noise-sensitive areas and has accelerated to close to Mach 0.4 or higher subsonic speed, the forward cowl inlet would be closed to take full advantage of inlet ram recovery, as shown in the middle illustration. The exhaust nozzle shroud also would be

challenge is modeling atmospheric temperature changes, wind, humidity and other factors that influence shockwave refraction. This will potentially require the AS2 to change its super-cruise Mach speed dynamically during flight to assure that no perceptible sonic boom that it creates reaches the surface.

The airplane routinely will cruise at FL 570 to FL 600, altitudes not attained by any civil aircraft except for the Concorde. Flight time between most business destinations will be 3 to 5 hr., such as London to New York, Montreal to Moscow and Paris to Chicago. The AS2 will shave off 2 to 4 hr. from most transpacific trips, even with a 1-hr. refueling stopover in Anchorage or Honolulu.

The biggest obstacle is money. The firm already has more than $500 million invested. Insiders believe it will take a total of $5 billion to get it to the finish line, 25% more than the firm predicted in 2018. Boeing and Spirit AeroSystems have suffered setbacks as a result of the Boeing 737 MAX grounding and the COVID-19 deep recession, causing them to pull back financial support for the AS2 and even to dissolve their engineering teams at Aerion.

Vice now forecasts first flight in 2025 and entry into service in 2027. Vincent's projections push out entry into service until 2029.

Is it worth the wait? Vice believes he can sell as many as 300 AS2 SSBJs during its first decade of production, bringing in as much as $40 billion at retail prices. He also believes that the AS2 is just the first step in returning supersonic aircraft to the civil market and envisions a world where travel distance no longer is a barrier. He also believes that innovation can solve environmental issues, most particularly sonic boom and carbon impact. Future Aerion supersonic aircraft will cruise faster and farther than the AS2, as well as carry more people. Commercial SSTs are in Vice's plan, ones with the net carbon footprint of Bertrand Piccard's Solar Impulse.

Even if Vice's plans at Aerion for a new generation of SSBJs and SSTs prove too ambitious, his Bob Bass-like "Go Big or Go Home" leadership approach will pay long-term dividends for the business aviation community. Environmental activists will continue to crank up the pressure on the aviation industry to slash or eliminate emissions, even though aircraft account for only 2.4% of the world's CO2 production. Plainly stated, business aircraft emit considerably more emissions per seat mile than jetliners, even though they only make up 2% of all aircraft emissions — 0.048% overall.

If the business aviation community zeroes out its net emissions by switching to 100% synthetic fuel and planting new forests to absorb CO2, it can pride itself on doing its part to help heal the earth. If new subsonic business aircraft can be built from renewable materials in manufacturing plants that emit near zero waste, future generations will laud the progress.

When Tom Vice talks about "disruptive change" at Aerion, it isn't just about speed. It's also about a revolutionary approach to how all aircraft can be built, operated and recycled so as to be kinder to the planet. That's a worthy goal all by itself. **BCA**

partially closed to reduce secondary airflow and to increase exhaust velocity.

The bottom illustration shows flight at Mach 1.4, with both the inlet cowl and exhaust shroud fully closed. The Affinity, similar to almost all turbine engines installed in supersonic aircraft, uses subsonic flow. The inlet spike creates an oblique shockwave that slows incoming air to about Mach 1.2 to 1.25. A secondary, terminal shock that forms just ahead of the engine inlet further slows the flow to about Mach 0.8 as air enters the engine inlet. The divergent shape of the inlet additionally decelerates the flow to about Mach 0.50 to 0.55 by the time air reaches the front face of the fan. Pressure rise caused by slowing the intake air from Mach 1.4 to Mach 0.5 is about 3.11:1 and inlet air temperature is 28C, assuming standard-day outside air temperature, due to a ram rise of 85C at 57,000 ft.

The exhaust nozzle shroud is completely closed around the exhaust plug to form a convergent/divergent nozzle. Exhaust flows are accelerated to supersonic speeds as they exit the engine to produce the thrust needed for Mach 1.4 cruise. **BCA**

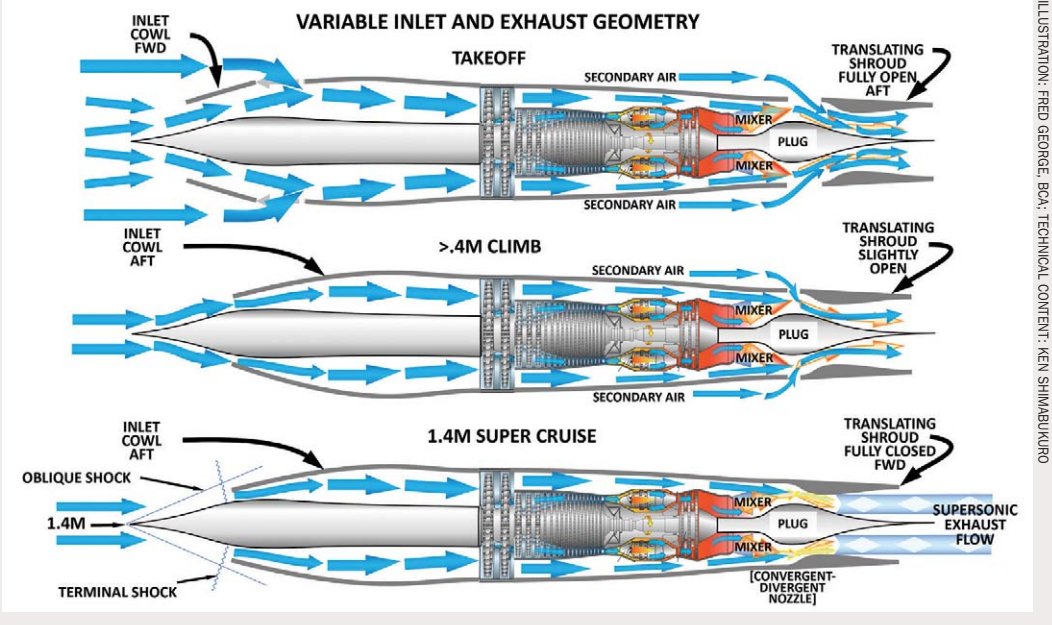

ILLUSTRATION: FRED GEORGE, BCA; TECHNICAL CONTENT: KEN SHIMABUKURO

Choosing an Aircraft Management Company

ISTOCKPHOTO

Does top-tier **quality mean sky-high pricing?**

BY **FRED GEORGE** fred.george@informa.com

The aircraft management business has been flooded with dozens of new entrants in recent years, many promising lower costs for a full range of support services. The appeal is great. Turnkey flight operations spare clients the hassles of dispatching, crew screening, maintenance oversight and insurance shopping.

Some management firms increase their appeal by offering to lease back aircraft from owners on an hourly basis and putting them to work in air charter operations. The owners are enticed with projections of substantial income from high-volume charter bookings that can potentially offset a sizable portion of fixed operating costs. That income promise may blur their view of the consequences resulting from additional wear and tear associated with high-tempo flight ops or to restrictions on aircraft availability for their own use due to charter bookings.

Bargain price, full-service aircraft management is a fiction, however. There is no such thing as a free lunch in this business, says David Rimmer, president of Talon Air in Farmingdale, New York. Discounters still must make profits to stay in business, so some firms skillfully cloak slews of upcharges in the fine print of management contracts. The final monthly bill may include handling fees, transaction charges, inflated foreign exchange rates and commissions of 15%, or more, on outside procurement invoices, among other costs.

"All those hidden profits. Let's call it what it is: dishonesty," says Rimmer. "Some of these firms just hate their customers, gouging them at every opportunity. 'We know that he or she can afford it,' they seem to believe." But it's OK to add surcharges to bills, Rimmer asserts, if all the upcharges are clearly explained to clients before they sign management contracts. "Transparency is key to every successful business relationship," he says.

Along with lack of transparency, many such startups just plain lack the expertise or resources to stay abreast of regulatory changes, maintenance records and legal issues.

"It's expensive to be in the aircraft management business, to be both legal and safe. If it seems too good to be true, it probably is. People get the management company they want, but not necessarily the one they need," Rimmer adds.

Econo-class management firms often look for ways to minimize people costs, including cutting corners on crew screening, qualifications and compensation packages, bone lean crew levels to support high-volume operations, requiring office staff to perform multiple functions with limited or no training and bending rules on dry leasing aircraft.

Many such cut-rate management firms collapse in a few years, due to financial setbacks, legal entanglements, FAA enforcement actions, insurance shortfalls or early termination of contracts by clients or their attorneys.

Economies of Scale, Long-Term Experience

Management companies can be divided into three categories: (1) large, nationally recognized firms that may be part of public companies or privately held firms, such as Clay Lacy Aviation, Directional Aviation's Corporate Wings, Executive Jet Management, Jet Aviation and Solairus Aviation; (2) medium-size firms, often created to complement FBO, aircraft sales and/or air charter businesses; and (3) smaller, locally based or regional companies, typically serving the

needs of family offices or a few high-net-worth individuals.

Staying power and employee retention are two key qualifiers when selecting aircraft management. Firms with low employee turnover typically screen job applicants carefully, offer attractive compensation and benefits packages, foster open and honest communications, meticulously comply with regulations and encourage teamwork. Larger management firms, ones that have been in business for decades and ones that manage sizable fleets of aircraft generally are more financially stable than small startups.

Owners should look for companies that have five or more aircraft under management, advises David Hernandez of the business law firm Vedder Price. He says that a management firm with "a large, varied fleet of aircraft [light, medium, heavy, etc.] will allow an owner to utilize a substitute aircraft if the owner's aircraft is grounded for maintenance or the owner needs a larger or smaller aircraft for a particular trip."

But Ryan Waguespack, senior vice president of aircraft management, air charter services and MROs at the National Air Transport Association (NATA), cautions that a management company cannot provide lift to one client using another client's aircraft without being an FAR Part 135 certificated air carrier having full operational control of the aircraft. That includes a Part 135 qualified crew, specific air-charter aircraft serial numbers listed in its ops specs and appropriate insurance coverage. The NATA's website allows visitors to look up charter operators by name or aircraft by N-number to verify their charter air-carrier certificate status.

Regardless of the firm's size, it's relevant to ask about the business aviation background, training, experience and education of managers, starting at the executive suite, then onto dispatchers, head of maintenance, crew scheduling, finance, accounting and reporting, and then all the way down to the individual client account manager.

In addition, it's essential to speak with the firm's safety manager about the company's safety management system, crew training requirements, crew duty and crew rest standards, and workplace safety practices. A good start is to check safety ratings by auditing firms such as ARG/US and Wyvern. IS-BAO (International Standard for Business Aircraft Operations) Stage 3 and IS-BAH (International Standard for Business Aircraft Handling) certifications add credibility to the firm's commitment to risk management best practices.

Established firms will also have their own FAR Part 145 repair station authorization, enabling them to accomplish many routine scheduled maintenance and line-service tasks in house. If the aircraft will be based away from the company's headquarters facility, aircraft owners need to determine how the aircraft will be supported, especially if it becomes grounded due to a maintenance snag.

Airplanes break. That's a reality of aircraft ownership. The acid test for an aircraft management company is its response when a client's airplane suddenly becomes unairworthy. What's the firm's Plan B? How quickly can it can arrange for a chartered aircraft to provide supplemental lift? How soon can it arrange for aircraft repairs? How well does it keep the aircraft owner informed of progress in restoring the aircraft to service? How carefully does it control costs?

A template to assist potential clients in assessing management company competencies is in the works. The NATA is in the process of creating a seven-step guide to best practices for aircraft management companies, says Waguespack. Focus areas include operations, finance, maintenance, legal, insurance, environmental protection including carbon emissions offsets, and cybersecurity. The guide will use input from Solairus Aviation, Duncan Aviation and Jet Aviation, plus Pentastar Aviation, Jet Professionals and Texas State Technical College, among others. Waguespack expects the first edition to be published in coming months.

Top Firms Offer Best-Practices Tips

Pentastar was founded in 1964 as Chrysler's flight department, serving the needs of the automaker's executives. It was spun off as an independent entity in 1980, pursuant to the U.S. government's $1.5 billion bailout of the company.

It's now one of the Midwest's leading aircraft management firms, caring for more than two dozen customer aircraft, mostly in the greater Detroit area. The firm has been growing continuously since it was acquired by Edsel Ford in 2001, and it now offers a wide range of services including charter, aircraft management, a Part 145 aircraft repair station (1995), aircraft interior refurbishment, avionics upgrades, FBO services and even aircraft acquisition consulting.

Pentastar puts special emphasis on recruiting, screening and retaining pilots. "They're the tip of the spear for our operation. We put our trust in them to manage situations [dynamically]," says Robert Rufli, Pentastar's vice president of flight operations. The flight crews are front-line customer service representatives with clients. Pentastar gives them full support, including a 24/7 dispatching team that provides weather briefing, trip planning, catering, handling and fuel arrangements, along with flight following, plus a maintenance control team.

Rufli says pilots must have access to all resources needed because of unforeseen circumstances. If an airplane breaks down on a trip, they need to coordinate through Pentastar's Pontiac, Michigan, headquarters for repairs, supplemental lift and ground transportation.

Meticulous recordkeeping in the process is top priority as well. "We place a premium on proper paperwork and maintenance," Rufli notes. "There are lots of changes to maintenance documents, including Service Bulletins and Airworthiness Directives. It's challenging for pilots if they have to double as [acting] directors of maintenance."

Thus, on long trips, Rufli often sends an airframe and powerplant technician along with the flight crew to provide line service, routine maintenance and repair coordination, if needed.

"We're committed to doing it right," says Rufli. "We're a service business. We want to work with clients to make it work for them."

Solairus Aviation in Petaluma, California, is a slightly younger aircraft management firm, partially having roots in Aviation Methods, which was founded in 1976. In line with Pentastar, Solairus positions itself as a service business. It now has grown to 750 full-time employees.

The firm prides itself on its "Sustainable Culture of Safety" for clients, passengers and team members. It has a full-time safety officer, a top-to-bottom integrated safety management system and it earned AR/GUS Platinum certification in 2009 as well as zero-discrepancy IS-BAO approval in 2010. Several

large corporate flight departments have conducted independent audits of Solairus, providing assurance that the firm's Part 135 charter service meets their own safety standards.

"We're looking for long-term business relationships. The secret sauce is to personalize everything, within constraints," says John King, Solairus' president. Prior to joining Solairus, King was the CFO at Sunset Aviation. He has three-plus decades of business and financial management experience.

"We're in the outsourced flight department business. We ask clients to tell us how to communicate with them. We personalize at every touch point, including having a dedicated client aviation manager [CAM], flight crew, flight attendant, crew chief and client responsible officer. We provide the same flight coordinator, the same finance contact, the same overseer to each client."

Solairus is rigorous in personnel screening, as the on-site CAM — usually also the client's chief pilot — is the principal point of contact to the firm on a daily basis. The on-site manager coordinates with Solairus' accounting, flight coordination and dispatch office, maintenance department, client services section, charter sales and aircraft acquisition divisions, among others.

Candidate CAMs and flight crews are technically screened, including a review of logs and training records, deep background checks and several stages of interviews. Then, Solairus meets with clients and introduces a list of personnel candidates to determine the best fit.

The crew chief is vital as that team member "keeps the aircraft flying, marrying up maintenance to the operating environment," King adds. For instance, if the aircraft is based at an airport in a salty air environment, the crew chief watches for any signs of corrosion.

Most management clients do not make their aircraft available for charter. The bulk of the charter fleet is dry leased and it is relatively young. Older aircraft are not used for charter because of reliability challenges.

Once the client signs on with Solairus, the firm provides monthly detailed financial reports that track all flight activity, fuel costs, charter activity, if applicable, and crew costs. Complete raw data is available so that clients can see the original invoices. The costs are not marked up with service fees, surcharges or handling fees. The monthly management fee is the only additional charge.

We asked King if we could talk to employees about their own experiences with Solairus. "Go ahead, talk to anyone and everyone," he responded.

So, we contacted Garrett Woodman, one of Solairus' long-time CAMs and a newly rated Gulfstream G550 captain, for his views. He says fleet discounts on fuel, insurance and maintenance have more than paid for Solairus' management fees for his clients during the past several years he's worked for the firm. Woodman has documented 10% to 20% lower maintenance costs made possible because of Solairus' volume purchasing power. Between 75% and 80% of Solairus' clients also take advantage of its fleet insurance policy. The fleet policy not only saves money, but also offers better coverage than an individual aircraft policy. "I'm the client-facing side of the account. I get very, very detailed end-of-the-month reports that I filter and check for errors," he says.

"Solairus constantly re-invests in infrastructure, refining accounting reports, providing more transparency, as well as supporting me and my family. From my perspective, there is no way to get closer to having your own flight department. It has the feel and sense of a private company," Woodman adds, noting that the firm has impressively strong employee retention.

Solairus also can assist clients in acquiring aircraft. Maintenance team members get involved with pre-purchase inspections, also coordinating with top-tier heavy maintenance facilities, such as Duncan Aviation and Gulfstream-Dallas, to evaluate aircraft condition and maintenance status.

Data security is a strong focus for the firm, with Solairus meeting ISO 2700 standards, King asserts. Clients are invited to actively audit the firm's data security system.

Cost Benefits and Intangibles

Large, well-established aircraft management companies charge as much as $14,000 to $16,000 per month per aircraft for their services. But firms such as Pentastar, Solairus, Executive Jet Management and Directional Aviation's Corporate Wings have bulk buying power that saves clients as much as 25% on fuel, a third on pilot training, 30% on maintenance and 50% on crew travel expenses, as well as negotiating hotel contracts for lower overnight costs. Some clients say they break even on management costs if their aircraft fly 400 hr. or more per year.

Regardless of the size of the management firms, clients are attracted to full-service companies because of the peace of mind that results. Customers are seeking professionals with broad and deep aviation experience, ones who adhere to the highest safety standards, firms that provide full disclosure of fees and complete transparency of all operating costs. They also want multiple aircraft redundancy, even though they only own one aircraft.

Thus, when a client's airplane is out of service for a scheduled inspection or unscheduled maintenance, a properly prepared management company can arrange for a chartered aircraft to provide supplement lift. When a client's regular flight crew is unavailable due to regular recurrent training, vacation time or illness, a full-service management company can provide temporary crew services. When new regulatory requirements loom on the horizon, a competent management company will alert the client to the challenge and provide guidance through the compliance process. When a client is lured toward "damp lease" gray market charter to offset operating costs, an ethical management company will steer the regular away from the temptation.

The least-expensive route to having an aircraft professionally managed by a third-party firm is to put it to work in air charter. In exchange, the client cedes some of the flexibility and convenience of having the airplane available on short notice.

Any management firm needs to be carefully vetted, including safety protocols, industry-accepted safety ratings, checking the experience of the staff, having an aviation attorney peruse the management contract, and verifying data security systems, among dozens of other checks. Good credit and financial standing of the management company are essential. Employee retention is another vital test of a firm's stability and staying power.

Signing on with a management company requires as much due diligence prior to inking the contract as when evaluating a new aircraft or entering into a long-term personal relationship. Attention to detail can make for an enjoyable, hassle-free business experience. Diving in without doing one's homework risks months or even years of financial, legal and personal woes. **BCA**

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Tail-End Ferry Fatigue

Get-home-itis isn't the only factor

IN SEPTEMBER, THE NTSB PUBLISHED A FINAL REPORT ON AN accident with a very simple determination of probable cause: "The pilot's loss of helicopter control as a result of fatigue during cruise flight at night."

The flight was a "tail-end ferry flight." Unlike FAR Part 121 operations, Part 135 charter operators have no rest requirements for a Part 91 repositioning flight at the end of the day. Part 91 flights at the beginning of the day or between Part 135 flights are counted, but the tail-end ferry flight home can extend a pilot's flight and duty time. It can't be counted as "rest," so the pilot would need the required rest before starting the next Part 135 day.

Tail-end ferry flights have been a part of the charter world since the original charter rest and duty rules were written. It has been confirmed by numerous FAA Legal Interpretations. In 2003, I served on an Aviation Rulemaking Committee (ARC) that sought to eliminate tail-end ferry flights as part of a comprehensive overhaul of outdated rest and duty regulations. The ARC's recommendations never made it to the Notice of Proposed Rulemaking (NPRM) stage. Now I serve on another ARC with the same goal of drafting enforceable, science-based rest and duty regs that fit the on-demand nature of the charter world.

Tail-end ferry flights have been a part of the charter world since the **original charter rest and duty rules were written.**

So, what does this recent tail-end ferry accident tell us? Would new regulations have prevented it? Here are the facts: It was an air ambulance helicopter, a Eurocopter AS350B2, with one pilot and two emergency medical service crewmembers aboard. They took off about 2107 on the final flight. It was night, but visual conditions prevailed. Prior to this flight, they had flown three others for a total of 94 min. of flight time over a period of 2.5 hr.

Shortly after takeoff, the pilot asked the crewmembers whether they were "alright." One crewmember responded, "Yup" and then asked, "Question is are you alright up there?" The pilot responded, "Uhhh, think so. Good enough to get us home at least." There was no further discussion related to fatigue.

During the flight, the pilot adjusted his seat position and flexed his legs, which were actions consistent with signs of fatigue. Also, although he participated in the medical crewmembers' conversations in the middle of the flight, he did not near the end. During the last portion of the flight, the helicopter entered a progressively steepening right bank, and the pilot did not respond as the medical crewmembers shouted his name. The helicopter descended and became inverted, and the pilot continued not to respond as the medical crewmembers shouted his name.

After the helicopter began to roll to the right, the pilot slumped to the left, appearing incapacitated. The crash occurred at approximately 2250.

The pilot and the two crewmembers were killed.

On the day of the accident, April 26, 2018, cellular telephone activity revealed two possible opportunities for the pilot to sleep before going on duty, but it is not known if he rested during those times. Thus, the pilot could have been awake for about 15.5 hr. at the time of the crash (based on telephone records showing activity at 0725 that morning) if he did not take advantage of the sleep opportunities.

The NTSB stated: "Although this time since awakening would not be considered excessive, this accident shift was the pilot's first after returning from a week-long vacation during which his circadian rhythm would have had him sleeping. Further, the environment created by the helicopter vibration, darkness of night, and few operational demands during the cruise phase of flight would have increased the pilot's fatigue and the body's biological desire to sleep."

There is little doubt that this experienced pilot simply fell asleep. But why? This accident didn't happen simply because the current regulations allow tail-end ferry flights. The cruel irony of this accident is that the pilot was coming off a week of vacation. The NTSB mentioned time-zone change, but the pilot, who was based in Wisconsin, simply took a week in Florida. A 1-hr. time-zone change was not a major factor. A bigger factor: circadian rhythms.

Pilots were talking about the dangers of flying "on the back side of the clock" long before scientists coined the phrase "Window of Circadian Low" (WOCL). This pilot switched to sleeping nights for a week. Then he gave himself a day to switch to becoming a night pilot. But the crash occurred before 11:00 p.m. He didn't make it to the backside of the clock. The WOCL for people adapted to a usual day-wake/night-sleep schedule begins around 2:00 a.m.

Part 135 needs enforceable, science-based rest and duty regulations. They do need to address the dangers of tail-end ferry flights, but more importantly, they need to introduce fatigue management principles so that pilots and operators better understand the risks of quickly changing their days to nights. **BCA**

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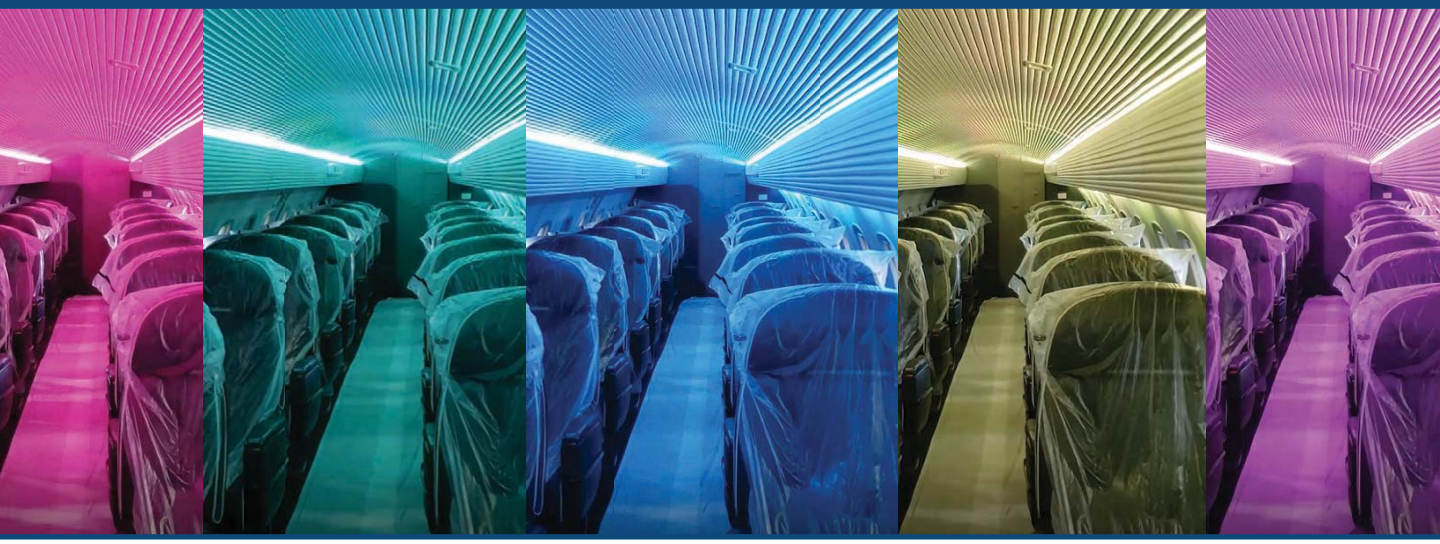

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Dassault Falcon 900LX

Top prices for best-in-class fuel efficiency

THE FALCON 900LX, THE FIFTH ITERATION OF DASSAULT'S LITHE, lean, large-cabin business aircraft, has been in service since late 2010. Its light weight and Aviation Partners Inc.'s winglets provide the best fuel efficiency of any competitive large cabin aircraft. Lighter weight also means lower landing fees at many European airports and less expensive carbon emissions taxes.

Normal cruise speed is Mach 0.80 indicated owing to the addition of winglets that increase aspect ratio from 7.62:1 to about 9:1. At that speed, it ekes out almost the same fuel efficiency as the Falcon 900EX without winglets cruising at 0.76 IMN. At 0.80 IMN, it has 200 nm more range than its predecessor, enabling it to fly 8 passengers between Paris and Minneapolis while cruising at 454 KTAS.

Slow down to max-range speed it can fly non-stop from London to Seattle, New York to Moscow, Le Bourget to Beijing and Mumbai to Luton. It's not the fastest jet that can connect such city pairs, but it's certainly the greenest because of its impressively low fuel consumption. On more typical 1,000 nm missions, Falcon 900LX's fuel consumption is up to 40% less. Fly 600 hr. per year and that could amount to more than 100,000 gallons of fuel saved. That's 1,100 tons less carbon dioxide.

DASSAULT

The Falcon 900LX is versatile. After touching down at max landing weight, it can fly 8 passengers nearly 3,600 nm without refueling. It can fly from Dulles to Teterboro, for instance, to pick up passengers, but no fuel. Then, it can fly from Teterboro to Moscow, according to Dassault Falcon Jet.

The main seating area is 23.5 feet long and it has 985 cu. ft. of volume. Most aircraft are configured with a conventional three-zone cabin, including forward four chair club section, center conference group with adjacent credenza and aft stateroom with sofa sleeper and single executive chair. The majority of aircraft can seat 12 people, but only 6 fully berthed for sleeping on overnight missions. Assuming a 26,750-lb. BOW, the jet can carry a 1,545-lb. payload with full fuel.

Up front, there are left and right side forward crew storage closets, a 30-in. wide A/V entertainment cabinet behind the main door, plus a 25-in. wide closet and 36-in. wide galley on the right side. The galley includes a cappuccino/espresso/coffee machine with hot and cold water spigots, a high temperature oven, two ice chests and sink with hot and cold water outlets. There are storage drawers, glass storage racks and a trash container.

There are forward and aft lavs, but no vacuum waste system. It's important to close the acoustical curtain over the entry door after takeoff to reduce wind noise. The 127-cu.-ft. aft baggage compartment is accessible up to FL 410. The bay also has a 37.4-by 29.5-in. external airstair door that makes easy work of loading and unloading luggage.

The Falcon 900LX is a delight to fly, having fully powered flight controls and speed proportionate artificial control feel in the pitch and roll axes. As we can attest, the straight strut, short travel, main landing gear require finesse in the flare to avoid embarrassing plop downs.

Most of the Falcon 50's legacy systems are carried over into the Falcon 900 family, including its split buss, 28 VDC electrical system, single air cycle machine, ground-use-only APU, straight-leg landing gear and tiller-only nose wheel steering. The flight deck features Dassault's second generation Enhanced Avionic System (EASy II) with available HUD and EVS, plus SVS PFDs. SB 900EX-401 provides LPV approach capability and SB 900EX-402 is the ADS-B upgrade. Other service bulletins provide FANS1/A, CPDLC, VDL Mode 2 for Europe and XM satellite weather.

Runway performance is an asset. Fully loaded, the Falcon 900LX needs 5,360 ft. of pavement when departing a sea-level, standard day airport and 7,615 ft. when taking off from *BCA*'s 5,000-ft. elevation, ISA+20C facility. Plan on burning 2,800 lb. the first hour and 1,700 lb. to 2,200 lb. each subsequent hour depending on aircraft weight.

Basic inspection intervals are 200 hr./2 months; 800 hr./12 months; 12/24/36 month calendar checks; 1,600-hr. B checks and 3,750 flight cycle/6-yr. C checks. Landing gear overhauls are due at 12 yr. or 7,500 landings. Dassault also offers an integrated Optimized Continuous Inspection Program that minimizes out-of-service time and tip-to-tail FalconCare maintenance. Budget $2,000 per hour for maintenance, plus $381.79 per engine/hour for MSP Gold and $110.90 per hour for APU MSP Gold. Engine compressor zone (overhaul) inspections are due at 6,000 hr., relatively short intervals for this class of aircraft.

Of the 81 Falcon 900LX aircraft in service, only two are for sale. Prices are *trés cher,* says Brant Dahlfors, co-founder of Newport Beach, California-based JetTransactions. These aircraft command $16 to $18 million because of their balance of runway performance, cabin comfort, range, speed and fuel efficiency. Dassault Falcon Jet product support now is second to none, another strong point.

Thus, the Falcon 900LX continues to retain a higher percentage of its original price than larger, heavier and considerably more fuel thirsty competitors. **BCA**

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On Duty

Edited by Jessica A. Salerno *jessica.salerno@informa.com*

▶ **Air Charter Safety Foundation** elected **Jessica Naor** to the board of governors. She is chief operating officer of GrandView Aviation, Middle River, Maryland.

▶ **APOC Aviation**, Rotterdam, appointed **Alexis Dufermont** director of Business Development responsible for expanding the diversifying the company's customer network.

ALEXIS DUFERMONT

▶ **ASU** (Aviation Specialties Unlimited), Boise, Idaho, announced that **Joe Estrera** will be the new president of ASU and **Hannah Gordon** will be promoted as the new chief operating office upon the retirement of ASU President Jim Winkle.

JOE ESTRERA

▶ **Bii.aero** appointed **Ian Foster** as MRO director focusing on global network of repair vendors and contracted programs.

▶ **Bombardier Safety Standdown**, Montreal, Canada, announced that **Antonio Cortes** has been named the 2020 winner of the influential Bombardier Safety Standdown Award. Cortes, a senior advisor for GMR Aviation Consulting, is a long-time supporter of the Standdown, delivering presentations and teaching workshops as well as servicing as chair of the Advisory Council.

HANNAH GORDON

▶ **Bombardier**, Montreal, Canada, announced appointments at its Biggn Hill service facility in London: **Greg Hoggett** is appointed general manager of the Service Centre; and **Corey Trudgen** will continue to support the important expansion project at the facility taking on a new mandate to actively support further footprint growth opportunities across the network.

DAVID HELFGOTT

▶ **C&L Aviation Group**, Bangor, Maine, has promoted **Todd Williams** to general manager. Most recently, Williams was director of operations for C&L Aerospace, a subsidiary. **Elizabeth Compher** will replace Williams as operations manager. Compher joined the company in April as repairs manager.

TROY NAIL

▶ **Duncan Aviation**, Lincoln, Nebraska, named **Troy Nail** Airframe Service Sales Manager and will be managing the airframe service sales team at its Lincoln and Provo, Utah, facilities.

SCOTT MEYER

▶ **Elliott Aviation**, Moline, Illinois, promoted **Roger Woolums** to Engineering manager at their headquarters in Moline. He will lead and oversee the company's inhouse engineering department, as well as product development.

▶ **Flying Colours Corp.**, Peterborough, Ontario, appointed **Scott Meyer** to the new role of Chief Operating Office. Meyer joined Flying Colours in December 2019 as vice president and general manager of the St. Louis, Missouri facility following nearly 30 years of international aerospace and aviation management experience.

DAVID MONACELL

▶ **GAMA, Washington, D.C.**, announced the addition of **Mustang Aviation** and **Seattle Aviation** solutions as members, and **NUAIR** and **Texas UASWERX** as associate members.

▶ **International Aircraft Dealers Association**, Boise, Idaho, selected **Joe Carfagna** of Leading Edge- Solutions as chairman for the 2021. The new vice chairman is **David Monacell** of CFS Jets.

▶ **Mente Group**, Dallas, Texas, named **Jamie Buff** as director of Technical Services for the broad-based aviation consulting firm. He has held significant aviation maintenance positions for AMB Group, Coca-Cola, Nike, P&G, Wachovia Bank, Cessna, and the U.S. Air Force.

▶ **NBAA**, Washington, D.C., announced that President and CEO **Ed Bolen** was reappointed to the NextGen Advisory committee.

▶ **SmartSky Networks**, Research Triangle, North Carolina, named **David Helfgott** CEO reflecting the company's transition to an operations aviation broadband communications service and products company. **BCA**

International Procedures Expert Guy Gribble Flies West

Guy Gribble, whose aviation career spanned military and airline flying and international procedures training for business aviation, flew west for the last time on October 26, 2020, after a protracted battle with cancer. His close friend and fellow Dallas resident Mitch Launius said Gribble "is remembered by his peers as a consummate professional dedicated to helping to elevate the standards and conduct of our industry."

A member of the National Business Aviation Association's International Operators Committee, Gribble was honored the week before his passing with a special award henceforth conferred in his name to IOC members who have distinguished themselves "with dedication and support to the safety initiatives and the overall betterment of business aviation international operations."

Gribble began his aviation career in 1977 as an Army aviator flying rotor-wing aircraft. He ultimately transferred to Naval Aviation, retraining to be a Naval Aviator, eventually piloting a Grumman EA-6B Prowler electronic warfare aircraft on and off of aircraft carriers including the USS Midway. When his military service ended, Gribble signed on with American Airlines, where he worked his way up the seniority ladder to oceanic operations in the left-front seat of the Boeing 767-300ER.

Guy Gribble is survived by his widow, Denise, their three children, William, Shannon, and Hanna, and three grandchildren.

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ADVERTISERS INDEX

December 1970 News

There's no doubt that **operating to more stringent** regulations is going to increase costs. Coming at this time, it will be **particularly bad.** —*BCA Staff*

Edited by Jessica A. Salerno *jessica.salerno@informa.com*

It is presuming on safety to operate any large airplane in accordance with the bare minimums of Part 91. . . . It is about time we took a hard and objective look at the general aviation operating regulations and measure their validity . . . .

Fulminating Females: From ATRs to parachute riggers, women are fast making inroads into the skies of private aviation. Sans the fulmination of the Lib Ladies, more than 29,000 women held pilot certificates at the end of last year, more than three times as many as a decade earlier. Some 3,500 additional women work in aviation as mechanics, ground instructors, dispatchers, control tower operators, flight engineers and flight navigators. California, Texas and Illinois, with 3,448 women active in aviation, lead the country in female participation.

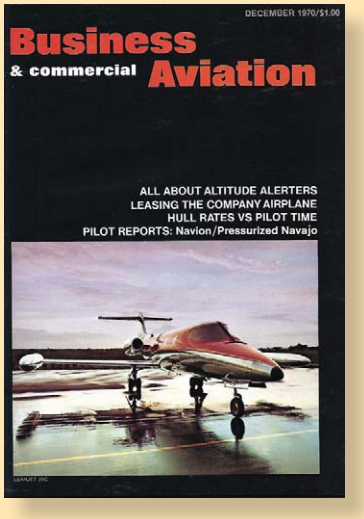
Simulator with all the moves: FlightSafety's new Gulfstream I trainer is hinged in three axes, permitting motion in roll, pitch and heave. It's designed for initial transition and refresher training.

First *BCA* "Cause & Circumstance" appeared in this December 1970 issue. Originally, it was almost a verbatim recap of the NTSB releases. Over the years, the column took on the personality of its many authors who would try to make sense of the accident and extract "lessons learned."

Navion Aircraft's one airplane is the last of the 250 Rangemasters produced since 1961. The Rangemaster in turn is the latest version to date of the Navion.

With 5.5 psi differential, the Navajo's pressurization system gives a seal level cabin up to 12,375 ft. and a 10,000-ft. cabin at 29,000 ft. The wing is a laminar section with a 2.5-deg. geometric twist. **BCA**

THE ARCHIVE



Light from the winter sky reflects off a wet ramp and the highly polished aluminum finish of this Learjet 25C to produce this striking and unusual photograph. Also, now the top model of Gates four-jet line. A 223-gal. fuselage tank gives the C model a 2,400-sm range with reserves. To make room for the tank, the rear pressure bulkhead was moved forward shrinking cabin size but still allowing a tight 8-seat or a more comfortable 5-place seating arrangement.

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FlightAware (flightaware.com)

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