

APRIL 2019 \$10.00 www.bcadigital.com

BCA

Business & Commercial Aviation



PILOT REPORT

Global 7500

A bespoke, personal flying flagship without equal

ALSO IN THIS ISSUE

Bad Ideas

Distracted, Disoriented
and Wrongly Determined

Balancing Work and
Life in Business Aviation

Cabin Ozone

AVIATION WEEK
NETWORK

Digital Edition Copyright Notice

The content contained in this digital edition (“Digital Material”), as well as its selection and arrangement, is owned by Informa and its affiliated companies, licensors, and suppliers, and is protected by their respective copyright, trademark and other proprietary rights.

Upon payment of the subscription price, if applicable, you are hereby authorized to view, download, copy, and print Digital Material solely for your own personal, non-commercial use, provided that by doing any of the foregoing, you acknowledge that (i) you do not and will not acquire any ownership rights of any kind in the Digital Material or any portion thereof, (ii) you must preserve all copyright and other proprietary notices included in any downloaded Digital Material, and (iii) you must comply in all respects with the use restrictions set forth below and in the Informa Privacy Policy and the Informa Terms of Use (the “Use Restrictions”), each of which is hereby incorporated by reference. Any use not in accordance with, and any failure to comply fully with, the Use Restrictions is expressly prohibited by law, and may result in severe civil and criminal penalties. Violators will be prosecuted to the maximum possible extent.

You may not modify, publish, license, transmit (including by way of email, facsimile or other electronic means), transfer, sell, reproduce (including by copying or posting on any network computer), create derivative works from, display, store, or in any way exploit, broadcast, disseminate or distribute, in any format or media of any kind, any of the Digital Material, in whole or in part, without the express prior written consent of Informa. To request content for commercial use or Informa’s approval of any other restricted activity described above, please contact the Reprints Department at (877) 652-5295. Without in any way limiting the foregoing, you may not use spiders, robots, data mining techniques or other automated techniques to catalog, download or otherwise reproduce, store or distribute any Digital Material.

NEITHER Informa NOR ANY THIRD PARTY CONTENT PROVIDER OR THEIR AGENTS SHALL BE LIABLE FOR ANY ACT, DIRECT OR INDIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OF OR ACCESS TO ANY DIGITAL MATERIAL, AND/OR ANY INFORMATION CONTAINED THEREIN.

WHEN YOU REACH THE TOP,
THERE'S ONLY ONE THING LEFT TO DO ...

KEEP RISING



Gulfstream™

A General Dynamics Company

THE ART OF EXCELLENCE

We've long had aviation down to a science. You inspire us to reach higher. Every day, we spark innovation, apply passion and perfect details. We advance aviation to an art form.



Keep up with all the news and blogs from BCA editors "like" us on facebook facebook.com/aweebca and follow us on twitter twitter.com/aweebca

44



Features

20 **Distracted, Disoriented and Wrongly Determined**

Richard N. Aarons

An approach so awful, the tower controllers ducked out of fear



DIGITAL EXTRAS



Tap this icon in articles in the digital edition of BCA for exclusive features. If you have not signed up to receive your digital subscription, go to aviationweek.com/bcacustomers

For the latest developments, go to www.bcadigital.com

Selected articles from BCA and The Weekly of Business Aviation, as well as breaking news stories and daily news updates

COVER

Courtesy of Bombardier Business Aircraft

40



28 **Bad Ideas**

James Albright

Aviation's two most dangerous words: "watch this"

28



35 **What's It Doing Now?**

Fred George

Prioritizing instrument standardization and simplification

40 **Cabin Ozone**

Patrick Veillette

Are you exposing your passenger and yourself to danger?

44 **Balancing Work and Personal Life**

David Esler

Being on call 24/7 is driving burned-out pilots to the airlines, and flight departments are reacting

52 **Pilot Report: Global 7500**

Fred George

A bespoke, personal flying flagship without equal

63 **A NextGen Primer**

Ross Detwiler

GPS positioning represents a quantum leap in ATC

11 **Intelligence**

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

Daher Upgrades TBM 940

Dassault Aviation Acquires MRO Operations

Boeing Selects Epic Fuels to Provide Sustainable Jet A

Leonardo to Certify AW609 by Year-end

FlightSafety Adds Drones to Their Training Mix

Embraer and Boeing Expect to Close Deal by Year-end



Fast Five With Chad Cundiff, President, Astronautics Corporation of America, Milwaukee



35

Departments

7 **Viewpoint**

24 **Accidents in Brief**

67 **Point of Law**

68 **20/Twenty**

70 **On Duty**

70 **Advertisers' Index**

72 **BCA 50 Years Ago**

69 **Marketplace**

THE WEEKLY OF
BusinessAviation

Trusted News and
Intelligence on
the *Business* of
Business Aviation
for 50 Years



Stay ahead with business
intelligence you can't find
anywhere else, delivered
to you.

Visit
www.aviationweek.com/wba
for your sample issue.

**AVIATION
WEEK**
NETWORK
an informa business

BCA
Business & Commercial Aviation

Editor-in-Chief William Garvey — william.garvey@informa.com
Executive Editor Jessica A. Salerno — jessica.salerno@informa.com
Senior Editor/Chief Pilot Fred George — fred.george@informa.com
Safety Editor Richard N. Aarons — bcasafety@gmail.com
**International Operations/
Features Editor** David Esler — david.esler@comcast.net
News Editor Molly McMillin — molly.mcmillin@informa.com
Art Direction Lisa Caputo — lcaputo@aviationweek.com
Art Department Scott Marshall — scott.marshall@aviationweek.com
Colin Throm — colin.throm@aviationweek.com
Associate Producer Bridget Horan — bridget.horan@aviationweek.com

Contributors James Albright — james@code7700.com
Mal Gormley — malgormley@gmail.com
Kent S. Jackson — kjackson@jetlaw.com
Ross Detwiler — rossdetwiler.com
Patrick Veillette, Ph.D. — jumpraway@aol.com
Ringston Media — info@ringstonmedia.com

Editorial Offices 520 Folly Rd., Ste. 238, Charleston, S.C.
(520) 638-8721 • (843) 718-2458

Publisher Beth Wagner — beth.wagner@aviationweek.com
Phone: (202) 517-1061

Managing Director, Directories Frank Craven — frank.craven@informa.com
Phone: (913) 967-1729

**Managing Director,
Business Aviation Intelligence/
Data Services** Anne McMahon — anne.mcmahon@aviationweek.com
Phone: (646) 291-6353

**Director of Sales,
Business Aviation** Elizabeth Zlitni — elizabeth.zlitni@informa.com
Phone: (913) 967-1348

**Advertising Production
Coordinator** Kara Walby — kara.walby@informa.com
Informa, 9800 Metcalf Ave., Overland Park, KS 66212
Phone: (913) 967-7476 • Fax: (913) 514-7303

**Senior Manager,
User Marketing** Tyler Motsinger — tyler.motsinger@informa.com
Phone: (913) 967-1623

**Head of Business Aviation
Fleet Data** Nigel Prevett — nigel.prevett@aviationweek.com
Phone: 407-314 7403

**Head of Valuations,
Business Aviation** Chris Reynolds — chris.reynolds@informa.com
Phone: (913) 967-1956

Subscription Information **BCA Customer Service:**
(800) 525-5003; +1 (847) 9147
Email: bca@omeda.com

Manage Your Subscription:
aviationweek.com/bcasubscribers

Reprints **Wright's Media**
Nick Iademarco — niademarco@wrightsmedia.com
Phone: (877) 652-5295 • Fax: (281) 419-5712

President, Aviation Week Network Gregory Hamilton — hamilton@aviationweek.com

**Managing Director—Civil Aviation
Administrative Offices** Iain Blackhall — iain.blackhall@aviationweek.com
605 3rd Ave., New York, N.Y. 10158

An Informa business

BCA - Business & Commercial Aviation (ISSN 0191-4642) is published monthly by Informa Media Inc., 9800 Metcalf Ave., Overland Park, KS 66212-2216. 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, 12 issues): United States and Canada, \$59.00; all other countries, \$79.00. For single copies/back copies call Customer Service at (800) 525-5003 in the United States and (847) 763-9147 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. Editorial contributions should be addressed to BCA, 520 Folly Rd., Ste. 238, Charleston, S.C. 29412, editorial address and must be accompanied by return postage. Publisher assumes no responsibility for safety of artwork, photographs or manuscripts. USPS 503-450.

Printed in the U.S.A.

Permissions: Material in this publication may not be reproduced, stored in a retrieval system, or transmitted in any form or by any means (electronic, mechanical, photocopying, recording or otherwise) without the prior written permission of the publisher.

Postmaster: Send address corrections to BCA - Business & Commercial Aviation, P.O. Box 1174 Skokie, IL 60076-8174. (Present subscribers include label)

© Copyright 2019 by Informa Media Inc. All rights reserved.



AC-U-KWIK

Things change. Do you know what to expect when you arrive?



The Airport and FBO data your trust, in the format you choose.
Print | Online | Digital App

Now Available to Order at
acukwik.com/products

AVIATION WEEK 
NETWORK

Advertising Sales

Publisher

Beth Wagner – beth.wagner@aviationweek.com
(202) 517-1061

Director of Sales

Elizabeth Zlitni – elizabeth.zlitni@informa.com
(913) 967-1348

North America Advertising Sales

Pacific Region

Miguel Ornelas – miguel.ornelas@aviationweek.com
(661) 480-7000

Midwest Region

Rob Howlett – rob.howlett@aviationweek.com
(949) 481-4519

Eastern Region

Cheryl Mahon – cheryl.mahon@aviationweek.com
(949) 481-4519

Florida, Georgia, South Carolina

Beth Eddy – betheddy@aviationexhibits.com
(561) 279-4646

Canada

David Seaberg – david.seaberg@vicbrownmedia.com
(416) 787-0914

Strategic Account Managers

Tom Davis – tom.davis@aviationweek.com
(469) 854-6717

Matt Holdreith – matt.holdreith@informa.com
(646) 719-0767

FBO Advertising Sales

Jodi Espinoza – jespinoza@acukwik.com
(913) 967-1651

Sara Hellon – sara.hellon@informa.com
(913) 967-1833

Jennifer Shafer-Doyle – jennifer.shafer@informa.com
(913) 967-1833

Worldwide Advertising Sales

Francine Brasseur – francine.brasseur@informa.com
(+617) 649-0411

Bettina Gentile – bettina.gentile@informa.com
(617) 649-0414

Michele Markarian – michele.markarian@informa.com
(617) 649-0420

Europe

David McMullen – david.mcmullen@aviationweek.co.uk
(+44 (0) 1925 596176

Andrea Prudente – andrea.prudente@aviationweek.com
(+44 207 152 4524

Israel

Tamir Eshel – invision@netvision.net.il
(+972 (9) 891-1792



Analyze the business aviation market to capture your next deal.

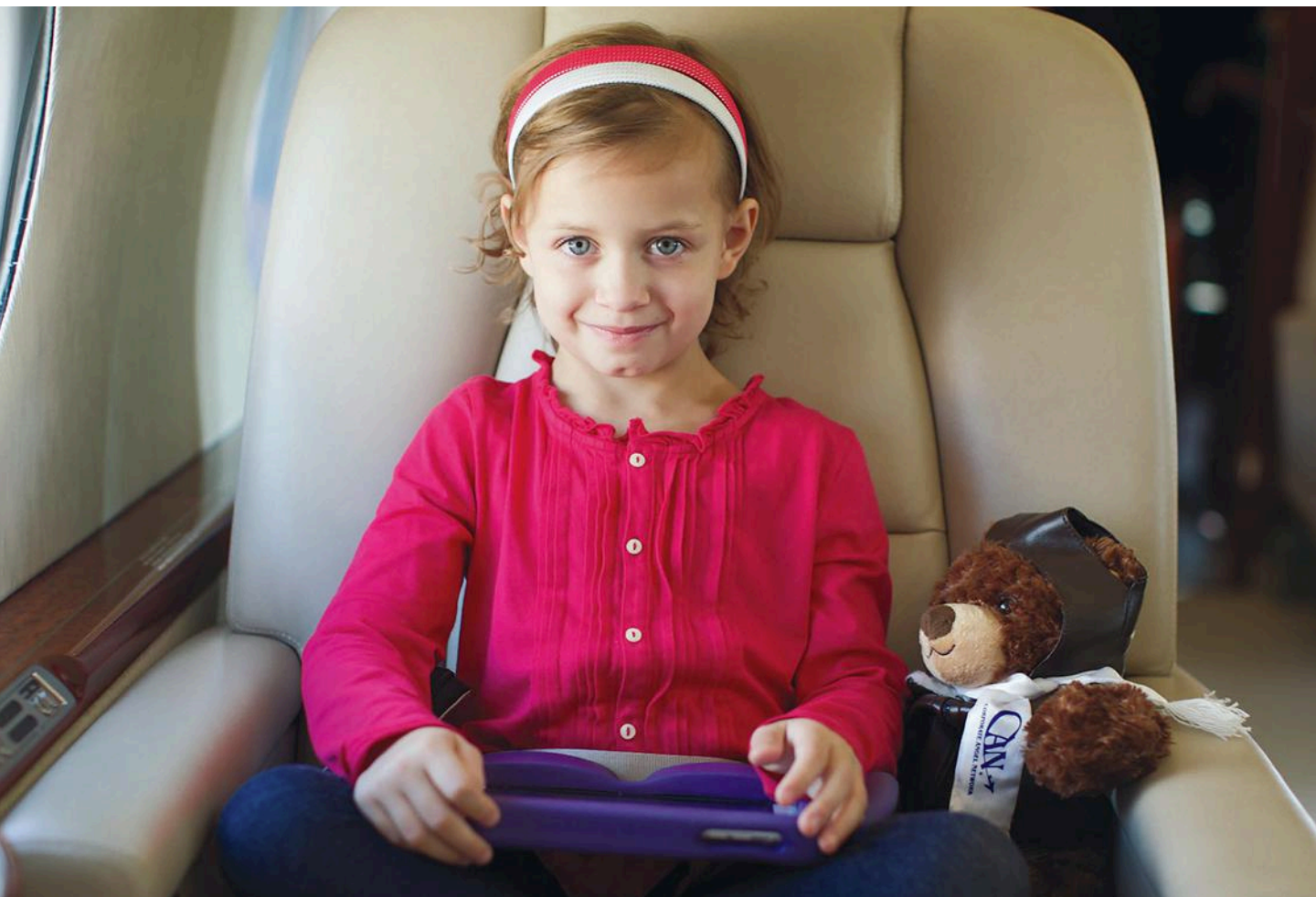
- Market and competitive insights
- Fleet data services: historical and current fleet ownership and status; forecast and valuations
- Research and analysis offerings

Take your business to the next level.

Visit pages.aviationweek.com/BusinessAviationSolutions

or call Anne McMahon at +1 646-291-6353 or
Thom Clayton +44 (0) 20 7017 6106

Bringing Cancer Patients Closer to Their Cure



Cancer Patients Fly Free in Empty Seats on Business Jets

- Corporate Angel Network arranges free flights to treatment for cancer patients by using empty seats on business jets.
- Since 1981, Corporate Angel Network, a not-for-profit organization, has worked with more than 500 corporations including half the *Fortune* 100, to fly close to 60,000 cancer patients to specialized treatment and currently transports 250 patients each month.
- The process is simple. Call or visit our website for more information.

Close to 60,000 flights and counting!



Corporate Angel Network

(866) 328-1313 WWW.CORPANGELNETWORK.ORG
TWITTER: @CORPANGELNET INSTAGRAM: @CORPORATEANGELNETWORK

50

Global Reach, Local Service.

These days, opportunity can knock right next door, across an ocean or across a hemisphere. So, isn't it good to know that the Embraer Executive Jet support network covers the globe?

There's always an Embraer Service Center nearby with experienced technicians who know our airplanes inside-out. In fact, our teams are so highly trained that they've helped us earn the FAA's coveted AMT Diamond Award for maintenance excellence for the last five years.

Whether you need routine technical and engineering support or more comprehensive maintenance packages, our Service Centers offer it all in one place.

We are with you wherever you may go.

TECHCARE



CHALLENGE.
CREATE.
OUTPERFORM.



Milestone Next

Rather than seclusion, **this is coming to city center**

AS ONE OF SEVEN SIBLINGS, MINE IS A LARGE AND EVER-GROWING family. When counting spouses, kids, their spouses and offspring, we're 61 strong, spread across 10 states with domiciles stretching from London to Maui. We communicate constantly and try to hold a grand family reunion once annually, typically around New Year's.

Thanks to an invitation by a friend of one brother to use his expansive beach house, this year's gathering took place in Nags Head, North Carolina. None of our tribe live near the place, and most, including me, had never visited. It was well worth the trip. Our reunions are always loud, full of laughter and storytelling — a happy chaos. But it was the proximity of Kill Devil Hills that made this gathering especially memorable.

Of course, I've known the Wright brothers' story since childhood. But reading my way through visitor center's displays, studying the Wrights' correspondence, seeing their actual equipment and listening to the U.S. Park Ranger's history lessons was like understanding the effort and achievement for the first time.

Bachelor brother bicycle builders in sleepy Dayton, Ohio, both with modest educational credentials, corresponded with the most notable aerodynamicists of the day, discovered errors in what were believed to be the formulas for lift and drag and recomputed them correctly, devising a wind tunnel in the doing. They created a glider design and fashioned the same. Wary of prying eyes, they sought out the most barren but windy place around and found it: Kitty Hawk, a desert-like setting on a thin barrier island that was virtually uninhabited and accessible only by boat.

A photo of the brothers' two wooden hangars standing alone in a vast sea of sand underscores both their isolation and their determination. They stumbled again and again and nearly quit their quest of flight, but ultimately in late 1903 they succeeded beyond imagining and changed the world and course of history forever in the doing.

There have been any number of significant aviation milestones since then — first flights across the English Channel, the Atlantic, around the world, ascending to the stratosphere, dogfighting, breaking the "sound barrier," and the invention of the jet engine, helicopter, autopilot, radar, instrument landing systems and GPS, among them.

My attendance at the Helicopter Association International's (HAI) recent HeliExpo in Atlanta strongly suggested to me that another milestone — possibly among the most significant

since that long-ago December day in Kitty Hawk — is in the making.

The prelude to the convention was a bit perplexing, even sobering. Even though all the major airframers — Airbus, Bell, Leonardo, MD, Sikorsky — are developing new products and refining existing ones, none held press conferences on the day prior to the ribbon cutting, which is traditionally press day. In fact, of the 10 or so time slots available for briefings in the single press conference room, only four were taken. By comparison, the NBAA's big annual meeting typically has three or four press conference rooms and on press day all the slots in all four are claimed.

To be fair, most of the majors held press events at their respective booths over the course of the convention, but even those were generally modest presentations — save for Airbus Helicopters' announced sale of 43 aircraft, half of them to Air Medical Group Holdings.

The paucity of news, it seems to me, can be attributed to three factors. First, low oil pricing continues

to negatively impact offshore servicing, and that segment accounts for a lot of medium- and heavy-lift helicopters. Second, much of rotary wing's technical advances are focused on military, not civilian, aircraft — there are several significant Pentagon competitions ongoing right now. And third is the wild card that's got every manufacturer's and seemingly every operator's attention: the rushing evolution of drones and electric-powered vertical takeoff and landing (eVTOL) urban air mobility vehicles.

The day prior to ribbon cutting, HAI President Matt Zuccaro told attendees that by embracing such vehicles, now and in the future, "the opportunities are unbelievable." He said unmanned and eVTOL machines are "not a threat" to helicopter operators "and you've got to get your heads around that." He called them "a supplement," another service to offer customers.

The fact is that every manufacturer is investing — some heavily — in this new, promising but unproven segment. However, a view of Atlanta's highway gridlock at rush hour supports its fruition and timeliness. In addition, Dan Elwell, the FAA's acting administrator, told the HeliExpo crowd that his agency has "embraced that technology" and plans to incorporate it into the national airspace and control system.

Whereto from here? I'll attend Aviation Week's inaugural Urban Air Mobility Conference this month, also in Atlanta, to find out. The location of our next family reunion could weigh in the balance. **BCA**



SUREFLY

Readers' Feedback

Timeless . . .

I mention "Aftermath" (Viewpoint, January 2007) here at CAE in Dallas multiple times to our clients. It is absolutely spot-on describing our profession. I just had one of my Eagle Scouts attend a Citation II initial course and get his CE-500 type rating. I shook his hand and congratulated him and, reminded him that this is a lifelong experience of learning and you'll never know it all. The most important attitude is to continually learn every single day. This profession can be the most rewarding job there is and they pay you for it, too!

I can't thank you enough for writing this piece. It is timeless.

Mike Silva

Training Manager

Citations, Americas

Civil Business Aviation

Helicopters and Maintenance Training

CAE

Dallas, Texas

Challenging, but Fun

"Operating in Argentina" (February 2019) was a well researched and very well written article. I lived in Buenos Aires for many years, and still travel there frequently. I was particularly pleased to see you highlight — several times — the need for documents, signatures, originals, etc. to be precise and in good order, as what would normally be a relatively painless process can quickly degenerate into a time-consuming drama if you are not well prepared. Over time, it will — or should — be increasingly easy to fly into Buenos Aires.

I fly into Jorge Newberry, but for many it was complicated even before the G20 — with ramp space limited to "regulars" (who had been parking there for years), limited to those N aircraft known-to or expected-by PSA, or foreign GOV/MIL flights — also complicated by government aircraft often parking on the "GA" ramp — that is the side opposite the MIL and the commercial ramps. Space constraints will not get any better — with relief at San Fernando or EZE being the best bet.

I was also pleased to see your "caveat" regarding the need to be careful with respect to the need for a Spanish speaker flying into some airports - indeed a concern. That said, something I found interesting and unexpected:

The Asunción airport broadcasting ATIS in English — with an English accent — and I don't recall it being broadcast in Spanish. Further, they turned us with a fuel stop in under 30 minutes — in and out — remarkable. We did not even have to call for fuel, as the fuel truck was waiting for us when we pulled up.

Having also lived in Brasil, I have counseled those flying to Brasil to be mindful of the need to speak Portuguese, or have at least some working knowledge



*Donned the mask, flipped the switch on,
took a breath . . . and something came out of the
mask and lodged in my throat. Something moving.*

Bob Bostwick, via the Web

— as if storms or fuel require a stop or diversion in the Amazon (broadly defined), the approach/ground controllers in much of central Brasil speak no English. You may find yourself needing to land at a non-towered airport with a Portuguese-only speaking ground coordinator/controller, making not only your arrival complicated by a language barrier but also complicating your obtaining a departure clearance. Having said that, every single person you are likely to come into contact with - despite a possible language barrier - and this goes for all of Latin America — is professional, courteous, and will do all they can to make the travel seamless.

Latin America is a great region to fly in and around, but uniformity from country to country is challenging — from Cartagena with what most U.S.-based pilots would consider a "real FBO," to Lima where being parked on the commercial ramp in between two 777s seems "normal," to Santos Dumont parking on infield taxiways ("ramp parking") just off the runway, etc. That is what makes it fun.

RHJ

Tulsa, Oklahoma

Missed Opportunity?

In your recent "Help Wanted" (Viewpoint, February 2019). You call for more aviation writers, but your article expands on the

shortage of pilots. I do not disagree with the need for more STEM or programs that you mentioned to enlighten future aviators, but it did not touch upon how to pursue aviation journalism.

There are young aviation professionals reading this article or magazine that could also like to write, but there is nothing about how or what to do about it. How did you start in aviation journalism? What path did you take to combine your two passions?

There is a known shortage but this magazine goes to people already in the industry. I think you missed a great opportunity to inspire people that could continue your love for it.

Nicole Emilianowicz

Flight Coordinator

Executive Aircraft Operations

Raytheon Company

Bedford, Massachusetts

Author's response: Probably the best way to begin is to study a publication, website, blog or video of interest then settle on a subject you'd like to address. Do some research, take a stab at writing and then propose it to the respective editor in charge. My career began as a daily newspaper reporter. I took flying lessons at a small airport — now gone — near the paper's offices. When *Flying* magazine gave me a freelance assignment, it occurred to me I might be able to combine the two pursuits. That was the real start of decades in aviation journalism.

Memory Lane

Your look at the graying (past tense) of the industry in "Help Wanted" (February 2019), of course was insightful. Including the sad truth that it's lost its mojo. A generation ago who would have thought this possible?

And your observation that, while in your 20s, most of your colleagues were contemporaries brought me to inwardly

respond, "Me, too." Moreover, we were schooled in the industry by a cadre of experienced publishers, editors and writers, including the likes of *AW&ST*'s Bill Gregory and Pete Bulban, *AIN*'s Jim Holahan, George Haddaway and Tom Ashley of *Flight* magazine, *Flying*'s Bob Parke, Leighton Collins at *Air Facts* and others.

One of the most important guys in my early aviation years (as he was to many others, I'm confident) was Dave Ewald, your magazine's long-time publisher. He once sat in on a Brownie troop meeting with my wife at our home until I showed up from my work at Learjet. Dave was a mold-breaker.

Al Higdon
Co-founder (Ret.)
Sullivan Higdon Sink
Wichita, Kansas

Young At Heart

Regarding "Help Wanted" (February 2019), I'll have you know that I'm still in my 60s. Not that old. At least for a few more months until I cross the 70 threshold.

You're point was well made. When we started we were the young guys. And we still are.

J. Mac McClellan
Former Editor-in-Chief, *Flying*
Currently King Air 200 captain
Grand Haven, Michigan

Check It

Patrick Veillette's "Oxygen Mask Failure" (February 2019) is a very good article, and I would like to add some thoughts to consider as a former maintenance test and ferry pilot on transport jets.

First, after you put on the masks and do your check in with each other, make another communications check five minutes after to ensure the regulators are working properly. I did an unpressurized ferry flight decades ago in a Boeing 727, and the whole crew properly tested our oxygen masks and regulators per the preflight procedures. Later, at altitude, we noticed our First Officer talking incoherently to ATC, and after checking, we discovered that even though the oxygen system tested fine on the ground, it malfunctioned in flight. We then used the observer's mask to provide necessary oxygen, and it was

remarkable when this person snapped back to coherency when the oxygen was flowing properly.

Second, as a maintenance test pilot bringing planes out of heavy checks, I cannot tell you how many planes had the following discrepancies: A. No cabin altitude warning horn; B. the passenger service units (rubber jungle) did not drop as prescribed.

If you are using goggles, be intimately familiar with the tiny vent on the front of your mask that is used to clear the goggles in the EMERGENCY position of the regulator. In extremely toxic smoke, this system is in my opinion, dubious in its effectivity. As a volunteer firefighter, we used full face mask air packs, and I can say definitively that this is more effective at protecting your eyes from toxic smoke. (It is thick, acrid stuff.)

Lastly, statistics are not with you in the event of an aircraft fire. Plan on landing quickly as soon as you discover you have a problem. There are many accident reports where after the fire was discovered, time was wasted trying to decide what to do. Your time left to remain alive is in minutes unless the fire can be definitively extinguished. If you doubt this, remember that your flight control cables are located in vulnerable locations throughout the aircraft. Once the pulleys melt, you now have no control of your plane.

Safe flying! Be professional and use that mask when necessary.

C.R. "Randy" McLain
Former Instructor/Check Pilot
Maintenance Test and Ferry Captain
Minneapolis, Minnesota

From the Web

Comment regarding "Oxygen Mask Failure" February 2019, by Patrick Veillette.

Great article. We fastidiously preflight everything but maybe not the mask . . .

Years ago I was the right seater in the 727, my habit pattern for checking the oxygen mask was to pull the mask off the spring loaded strap it was hanging from, test for flow without putting it on, and reinstall the mask on the strap. Yup, I was not doing a full check and that was



my habit pattern until I got an education.

Just by chance, during one preflight I decided to take the mask off the strap, put it on, and give it a full test, along with taking out the smoke goggles

and seeing how well it all worked with my glasses on. Had a sim ride the next day and knew using the mask would be part of the drill.

Donned the mask, flipped the switch on, took a breath . . . and something came out of the mask and lodged in my throat. *Something moving.* After ripping off the mask and doing some very dramatic coughing and heaving (while the Captain and Flight Engineer were watching and wondering what the heck was wrong), I finally spit out a fairly good sized live moth!

Wow. How did that happen? Didn't take long to figure it out, the mask hangs from the top left corner of the Flight Engineer panel, and just above the attach point is one of the flood lights for the panel. Hmmm. Light attracts bug, bug gets tired, bug falls into mask.

A good lesson, from that point on in my flying career I made it my habit to pull the mask out of wherever it was, clean it with a mask wipe, put some pressure to it, check it, then put it on and check for function and communication. And yes, on several occasions there was another moth in the mask.

Can imagine how bad things could go with smoke/fumes/loss of pressurization and inhaling a moth with that first deep breath.

Bob Bostick, Jr.
Captain (Ret.),
FedEx

Correction: The photo used inadvertently in "Tracking Tires" (March 2019) involved a fatal landing overrun accident in Greenville, S.C. in 2018.

If you would like to submit a comment on an article in *BCA*, or voice your opinion on an aviation related topic, send an email to jessica.salerno@informa.com or william.garvey@informa.com

ULTRA TALL. ULTRA WIDE. EVERY INCH A FALCON.



Get ready to experience the tallest and widest cabin in business aviation. The Falcon 6X has a 5,500 nm (10,186 km) range and a top speed of Mach .90. And like all Falcons, it performs with utmost efficiency even at challenging airports. **Falcon 6X. The roomiest, most productive 5,500 nm you'll ever experience.**

Falcon 6X
A CLASS ALL ITS OWN

WWW.FALCON6X.COM | FRANCE: +33 1 47 11 88 68 | USA: +1 201 541 4600

DASSAULT
AVIATION

ENGINEERED WITH PASSION

INTELLIGENCE

EDITED BY **WILLIAM GARVEY,**
JESSICA A. SALERNO AND
MOLLY MCMILLIN
william.garvey@informa.com
jessica.salerno@informa.com
molly.mcmillin@informa.com

NEWS / ANALYSIS / TRENDS / ISSUES

► **DAHER HAS UNGRADED ITS SINGLE-ENGINE TURBOPROP.** The new TBM 940's improvements include an automated throttle, automatic deicing system, and style and ergonomic cabin enhancements such as redesigned seats, additional thermal insulation for



the sidewalls, a new central shelf with side storage, an additional 115-volt electrical outlet at the rear seat panel and USB ports. European Aviation Safety Agency (EASA) and FAA certifications were expected to be received at Aero Friedrichshafen 2019 in Germany this month. Deliveries are sched-

uled to begin in late spring. "The TBM 940 redefines the ultimate private aircraft: user-friendly, safe and efficient for both pilots and passengers," said Nicolas Chabbert, senior vice president of the Daher Airplane Business Unit. The TBM 940 includes Garmin 3000 avionics. It has a maximum cruise speed of 330 kt. and a range of 1,730 nm, the same as the TBM 930.

► **ACTING FAA ADMINISTRATOR DAN ELWELL SAYS** the agency's role is to "enable the emergent UAS [unmanned air systems] industry," but to do so in a way that "doesn't in any way reduce or impinge on the viability of the growth prospects of the rest of the NAS [national airspace system]." In early March he told attendees at both the Helicopter Association International's Heli-Expo and those attending a legislative summit co-hosted by the Airports Council International-North America and the American Association of Airport Executives in Washington that the FAA has no plans to segregate drones from the rest of the airspace. He noted at the latter that the population of more than **100,000 registered drone operators flying more than 300,000 commercial-registered drones is too large to segment within an NAS already plagued by congestion constraints.** Elwell also said he "will fight" to make sure the FAA does not assume responsibility for counter-UAS operations, saying that doing so could risk unleashing "a host of unintended consequences." Instead of having the agency manage counter-UAS duties, he pointed to arrangements worked out between the FAA and the Departments of Energy, Homeland Security and Justice to shoot threatening drones out of the sky as a model for how the FAA could collaborate with airports in the future.

► **BOEING HAS SELECTED EPIC FUELS TO PROVIDE SUSTAINABLE** Jet-A fuel for its new aircraft delivery program and has begun offering customers its use on new airplane delivery flights from its facilities in Washington state's Puget Sound region, and eventually from its 787 facility in North Charleston, South Carolina. **Alaska Airlines, an early pioneer in embracing sustainable fuels, is the first participant in the Boeing initiative and later this year will take delivery of three 737 MAX airplanes powered by a blend of biofuel and traditional jet fuel.**



"As a world-class fuel provider, Epic Fuels recognizes the need to find viable, sustainable and safe alternatives to petroleum-only based aviation fuel," said Kai Sorenson, director of commercial sales for Epic Fuels. "We've gained tremendous

working knowledge on the transport, safe handling and blending of biofuel. . . . Programs such as Boeing's option to provide biofuel are made possible not only by their tireless commitment to protect the environment, but also because of the many demonstration flights in previous years that have helped to identify and fast-track technologies that can improve the environmental performance of alternative aviation fuels," Sorenson added.

Jet-A and Avgas Per-Gallon Fuel Prices

March 2019

Jet-A			
Region	High	Low	Average
Eastern	\$8.84	\$4.53	\$6.32
New England	\$7.71	\$3.90	\$5.21
Great Lakes	\$8.37	\$3.90	\$5.59
Central	\$7.75	\$3.37	\$4.98
Southern	\$8.32	\$4.20	\$6.06
Southwest	\$6.87	\$3.35	\$5.32
NW Mountain	\$7.80	\$3.30	\$5.34
Western Pacific	\$8.35	\$3.60	\$5.97
Nationwide	\$8.00	\$3.77	\$5.60

Avgas			
Region	High	Low	Average
Eastern	\$8.57	\$4.90	\$6.50
New England	\$7.45	\$4.75	\$5.87
Great Lakes	\$8.59	\$4.59	\$6.03
Central	\$7.59	\$4.31	\$5.35
Southern	\$8.19	\$3.70	\$6.04
Southwest	\$6.99	\$4.00	\$5.56
NW Mountain	\$8.46	\$4.65	\$5.80
Western Pacific	\$8.52	\$4.90	\$6.24
Nationwide	\$8.05	\$4.48	\$5.92

The tables above show results of a fuel price survey of U.S. fuel suppliers performed in March 2019. This survey was conducted by Aviation Research Group/U.S. and reflects prices reported from over 200 FBOs located within the 48 contiguous United States. Prices are full retail and include all taxes and fees.

For additional information, contact Aviation Research/U.S. Inc. at (513) 852-5110 or on the internet at www.aviationresearch.com

✦ For the latest news and information, go to aviationweek.com and bcadigital.com

Boeing Purchases Houston-Based ForeFlight



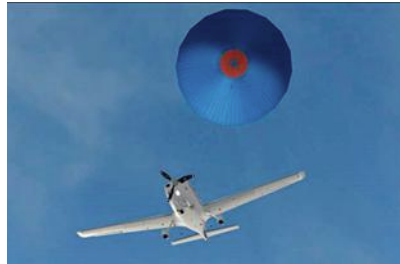
The Boeing Co. continues to expand its number of subsidiaries, recently closing on ForeFlight, a provider of mobile and web-based aviation applications. For the past two years, ForeFlight and Boeing have partnered to bring aeronautical data and charts of Jeppesen, another Boeing subsidiary, through ForeFlight's mobile platforms. The teams will now integrate offerings for all segments of the aviation industry.

True Blue Power Introduces Gen5 Battery



True Blue Power, a manufacturer of lithium-ion aircraft batteries, has introduced fifth-generation main ship batteries called True Blue Power Gen5. The company says the batteries, which weigh less than traditional batteries, are engineered to address lead-acid and NiCad challenges. The batteries eliminate expensive battery maintenance, frequent capacity checks, low-voltage operational delays and the majority of battery-related aircraft-on-ground situations. The Gen5 engine-start batteries communicate real-time state-of-charge and state-of-health data. Battery configurations are programmed for specific aircraft.

► **BRS AEROSPACE REPORTS ITS WHOLE AIRCRAFT PARACHUTE** system recently saved two lives — its 400th and 401st saves — noteworthy achievements in aviation safety. “This milestone and all of the lives saved is a testament to Boris Popov, who conceived the idea and whose vision for the company he founded overcame initial resistance to the very idea of aircraft parachutes from some naysayers,” said BRS President/Director Enrique Dillon. “The concept’s legacy are the pilots and passengers who survived to continue to live fruitful lives and the thousands of families who have enjoyed added peace of mind when their loved ones fly.” The milestone saves occurred March 5 when the pilot of a Cirrus aircraft with a failed engine deployed the parachute over water more than 20 mi. from Grand Turk Island in the Turks and Caicos. Reportedly, both pilot and passenger were not injured and were



picked up by a cruise ship. The parachute system is deployed by a rocket to slow the aircraft in the airstream and then lower it and its occupants to the ground in a measured descent. **The parachute and solid propellant ballistic rocket assembly are enclosed in a canister** mounted inside the fuselage that is activated manually or automatically. All Cirrus models, including the Vision jet, are fitted with the system. With more than 30,000 systems installed during the past 35 years on aircraft including homebuilts, light sport and certified aircraft and military trainers, BRS says that approximately one of every 120 systems has been activated as a last resort. “While we hope pilots never encounter a troubling situation, **we salute BRS Aerospace for the 400 lives its parachute system has saved when something did go awry in the air,**” said General Aviation and Manufacturers Association President and CEO Pete Bunce. “I fly routinely with two different types of aircraft equipped with parachutes and I am a true believer in the safety benefit of these systems.” “The very idea of saving an entire aircraft through a deployable parachute system is an ingenious invention that deserves its place in the history of safer flight,” said Richard McSpadden, executive director of the AOPA Air Safety Institute. “BRS pioneered the concept in certified airplanes and deserves recognition for delivering an innovation proven to be a substantial milestone in the ongoing evolution of aviation safety.”

► **HONEYWELL'S TURBINE-POWERED CIVIL HELICOPTER** Purchase Outlook is forecasting some 4,000 new civil helicopters could be delivered by manufacturers over the next five years, with notable growth in the law-enforcement market and increased fleet utilization from oil-and-gas crew change operators. Nevertheless, the forecast shaved 200 helicopters from its outlook last year. Single-engine models remain the most popular models, representing 65% of North American purchases, but Honeywell says there is increased interest in intermediate and medium twin-engine types. Although the slightly lower numbers appear to reflect a dimmer view of the global economic outlook, **the survey says there still will be 3-4% growth in annual deliveries.** Heath Patrick, Honeywell's president for aftermarket business, said, “Despite positive impacts of U.S. tax reform on new helicopter purchase plans in North America, an inconsistent economic outlook for international markets has resulted in lower purchase plans worldwide from fleet managers when compared with a year ago.” In Europe, the view was less positive, with only 15% of operators stating they were planning to replace or expand their fleet with a new helicopter over the next five years. The company said this figure was 22% in 2018. The survey reveals expectations of stronger growth in the Asia-Pacific region, with 21% of China's fleet forecast to be replaced or expanded with a new platform in the next five years. Significant expansion also is envisaged in India, the survey suggests.



NEVER HIT PAUSE

Work without interruption. Meet with your team while inflight. Low latency enables the face-to-face connections that increase productivity everywhere.

The Most Compelling User Experience • smartskynetworks.com/ATG • 800.660.9982

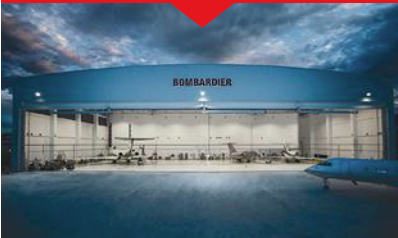


RUAG Australia Earns EASA Part 145; Receives Patent



RUAG Australia has earned certification as an EASA Part 145 maintenance organization. The Australia facility offers component MRO and line support for airline and leasing fleets in Europe and Australia. RUAG also has been awarded full patent rights in Australia, Europe and the U.S. for its Methods for Treating Aircraft Structures. The patent identifies the use of additive metal technology, Supersonic Particle Disposition, as a fully certifiable alternative for safe and reliable repairs, according to RUAG.

Bombardier Expands Singapore Service Center



Bombardier is boosting its customer service capabilities in the Asia-Pacific region by expanding its Singapore Service Center. It will be the largest aviation maintenance facility in Asia owned by an OEM and will have the ability to support more than 2,000 visits a year. Bombardier is quadrupling its existing footprint, adding a paint shop and parts depot and expanding its interior finishing shop. Additional hangars are expected to be fully operational in the second half of 2020.

► **SWITZERLAND-BASED NEWCOMER KOPTER GROUP**, the manufacturer of the new SH09 single-engine light helicopter, hopes to eventually assemble as many as 100 of them annually at a Lafayette, Louisiana, facility established with Bayou State to produce Bell's Model 505 JetRanger X. The company wants to begin work there starting in 2020, within months of the SH09's planned European Aviation Safety Agency (EASA) and FAA certification. The company — previously known as Marengo Swisshelicopter — has already secured two and a half years' worth of production for the rotorcraft, with 50% of those orders coming from U.S. customers. In Lafayette, the company will assemble kits delivered from Switzerland and carry out customization for customers in the U.S., Canada and potentially Latin America. The site will also be the company's North American support hub. "We chose Lafayette because of its proximity to the operator landscape, the highly skilled workforce and access to other suppliers," Kopter CEO Andreas Lowenstein said at Heli-Expo in Atlanta in March. "We have here a turnkey solution; we need to do some transformation . . . but this is a facility that has been built to assemble and deliver helicopters. . . .



That makes us gain a lot of time for industrial setup." Kopter will lease the 84,700-sq.-ft. facility from the Lafayette Airport Commission and benefit from industrial tax exemptions and \$2.5 million of subsidies that will go toward renovation and leasing costs for the site. In return, it must employ 120 workers and generate a \$7 million payroll. Bell vacated the site last August; Louisiana cut the incentives, saying the manufacturer had failed to create the promised 95 full-time jobs. The company had planned to assemble the Model 505 there but moved that work to its plant in Quebec, Canada. Bell subsequently sited Model 525 cabin-subassembly work at Lafayette instead, but delays to that program resulted in just 22 jobs being created. Lowenstein says the 120 jobs will be a "first step." **He hopes Kopter's presence in the U.S. will enable it to "access public markets,"** targeting tenders for agencies such as the Department of Homeland Security and the Defense Department. "With this setup, we will reach levels of American content that will allow us to be an integral part of bigger contracts of that type in the future," he says. The Lafayette facility represents a major investment for the newcomer, which has yet to deliver an aircraft. Kopter is hoping to finalize additional financial backing, worth up to \$250 million, to also support the certification and ramp-up process. The company has so far been funded by a single backer. But Kopter needs to certify the aircraft first, and despite the first prototype of the SH09 making its first flight in November 2014, it has taken development of the third prototype to truly open the flight envelope. Certification is planned for the second quarter of 2020. Discussions are underway with the FAA for certification in the U.S.

► **THE FARNBOROUGH AIRSHOW IS ENDING ITS PUBLIC WEEKEND** air show days. Under the new format, the next event, set for July 20-24, 2020, will be held over five days instead of seven. **The public will be allowed access on July 24.** Farnborough Air-



show CEO Gareth Rogers said the move will allow visitors "to see more of the people, products and processes that underpin the global aerospace, defense and space industries." The public element of the show has struggled in recent years to live up to expectations. This is partly due to restrictions on flight performances following the fatal crash at the Shoreham Airshow in 2015 in which 11 people died. "Removing the public weekend will disappoint some, but for our exhibitors and trade visitors the focus is on business and accessing the talent they need to sustain global competitiveness," Rogers said.

► **DASSAULT AVIATION RECENTLY ACQUIRED TAG AVIATION'S** European maintenance activities and the maintenance, repair and overhaul operations (MRO) of the ExecuJet Group, which offers product support at several locations in Asia-Pacific, the Middle East, Africa and Europe, including four in Australia and New Zealand, signaling a strategic shift to capture more revenue from its Falcon Jet models over their operational lifetimes. While new



aircraft sales remain relatively slow, growth prospects for MRO activities are attracting airframe manufacturers, notably including Boeing. The expected income may help fuel Falcon Jet research and development. Industry-wide, MRO services for turbine-powered business

aircraft will amount to \$14 billion in 2025, thanks to those services' 2% annual growth, according to New York-based consultancy Oliver Wyman. That will be faster than the expected annual 1.4% growth of the global fleet. Moreover, MRO activities are so regulated that the prediction can be seen as much more solid than a new aircraft sales forecast. And a business jet may be in service for 25-30 years or longer. To secure revenues, Dassault — like other airframers — offers its customers a “pay as you fly” program, which it has branded Falcon Care. An increasing proportion of owners sign up for such worry-free services. Not only can MRO bring increased revenue, but those services bring valuable information as well. The service center learns how customers use their aircraft and identify troublesome features.

► **BOEING AND EMBRAER EXPECT TO CLOSE THEIR DEAL-MAKING** over commercial and defense aircraft joint ventures (JV) by year's end, now that Embraer shareholders approved the proposals. Two-thirds of the Brazilian planemaker's shareholders voted in an extraordinary meeting at Embraer's headquarters in Brazil in late February, with nearly 99% of them backing Boeing's 80% takeover of Embraer's commercial business, as well as a 49-51% JV to market Embraer's KC-390 military airlifter. Embraer's board had already approved the deals, and critically, Brazil's president also announced he would not block it. Boeing agreed to pay Embraer \$4.2 billion for the commercial JV. Embraer is also likely to pocket about \$3.1 billion net from the commercial sale. And the military joint venture could generate synergies of about \$50 million per year for Embraer, including equipment procurement, the analysts say.

► **TRU SIMULATION + TRAINING, A TEXTRON SUBSIDIARY,** has delivered a full flight simulator (FFS) for the Bombardier CL-415 “water bomber” amphibious aircraft to Ansett Aviation's training center in Milan, Italy. It is the first Level D FFS of its kind. Previously, most CL-415 training had been in the actual aircraft, where pilots had to practice aerial fire-



fighting missions. That created a “significant” safety hazard, said Thom Allen, Tru Simulation's vice president of technology and innovation. With the simulator, pilots now can train for real-life scenarios — including water scooping, water landing and water takeoff, and taxiing — outside of the aircraft. The CL-415 can scoop 13,500 lb. of water in 10-12 sec. and drop it in 6 sec.

“Flying these missions is just unbelievable,” Allen said. In missions, pilots are scooping water onto the aircraft, flying 100 ft. off the ground and maneuvering through flames and smoke. “Think of the turbulence and updrafts that come because of the fire,” Allen said. The aircraft's weight changes quickly as water is dropped on the flames. “It's not something you normally do in an airplane,” Allen said.

FSI Adds Airbus Helicopter Training in Denver



FlightSafety International has added new training courses for Airbus Helicopters at its Denver Learning Center. The Center now offers FAA-approved Part 142 Initial, Recurrent and Prior Experience courses for the EC130T2. Other programs include EC130T2 Initial, Recurrent and Recent Flight Experience Night Vision Goggle courses, and AS350B3 differences training for the AS350B2 and AS350B3e/H125.

Arab Air Carriers Organization Signs MOU With MedAir



The Arab Air Carriers Organization (AACO) has signed a memorandum of understanding with MedAir for aviation security and assistance services. The initiative aims at assisting airlines in receiving timely, accurate and actionable information to enhance their threat and risk assessments; Member airlines will receive airspace and airport assessments, access to travel safety and security advice, security and operational assistance and other services. About 230 million passengers flew with AACO-member airlines in 2018.

FAA Selects Wing for UAS Traffic Management Program



Wing, the drone delivery subsidiary of Google parent company Alphabet, has been selected by the FAA to participate in the agency's unmanned aircraft system traffic management (UTM) pilot program. Planned through September, the intent of the UAS Traffic Management Pilot Program (UTM) is to identify industry and FAA capabilities needed to support a UTM construct for managing multiple, simultaneous drone flights at low altitude, in airspace where the FAA does not provide air traffic services.

Jet Aviation Rebrands Australian Hawker Pacific FBOs



Jet Aviation has completed the re-branding of its six Hawker Pacific FBOs in Australia. The facilities are located in Brisbane, Cairns, Darwin, Perth and Sydney. As of Feb. 1, all six facilities operate under the Jet Aviation name. Jet Aviation acquired Hawker Pacific in May 2018. The company operates 34 FBOs globally. "The Australian FBOs have a history of strong performance and will continue to deliver exceptional customer service under the Jet Aviation brand," says Joe Reckling, SVP regional operations APAC.

▶ **AFTER A NEAR-DECADE-LONG HIATUS, SCHWEIZER** helicopters are about to return to production. Schweizer RSG, which bought the rights and type certificate to the piston-engine Schweizer S-300 family and turbine-powered S-333 from Sikorsky in January 2018,



will produce two new-build S-300 piston helicopters later this year, paving the way for full-rate production in 2020. The company has now secured 30 orders, including an \$11 million order for 25 S-300CBI models announced at Heli-Expo on March 5. But perhaps most importantly, the company is re-establishing a supply chain of parts and components and helping return aircraft to flight, some after years on the ground. "We know this has been a long journey for some operators," said David Horton, president of Schweizer RSG. "The supply chain is up and running . . . by the middle of this year we should have everything that anybody would need to operate our helicopters."

▶ **DASSAULT AVIATION WILL NOT BE PARTICIPATING** in any supersonic business jet project. "The problem is noise and emission standards. They have changed since Concorde," CEO Eric Trappier said in late February. A low-boom aircraft would still be too noisy at takeoff, he said, and a supersonic aircraft would also burn more fuel than a subsonic one. In the U.S., the Trump administration is pushing for relaxed ICAO standards that would allow supersonic aircraft to fly, Trappier said. In its 2018 reauthorization legislation, Congress directed the FAA to develop a unique noise standard for supersonic aircraft. "With Airbus, we are trying to understand what is going on," Trappier said. Answering a suggestion that U.S. projects like Aerion and Boom Supersonic are not serious, Trappier asserted that used to be true a few years ago. But it is no longer the case, he insisted. The FAA is ready to change its own standards and NASA is investing, he explained. Therefore, "there is a non-negligible risk that a U.S. company develops a supersonic transport or business jet." A business case has yet to be found, however. Development costs would be extremely high, while production would be limited. "What if European airports ban such aircraft?" Trappier asked. **Dassault worked on a supersonic business jet in the late 1990s**, leveraging its long experience in both business aviation and fighter aircraft. Citing the lack of availability of a suitable engine, it shelved the project in 1999. In the following years, the company still hoped to one day resurrect the project, and talked to Boeing and Sukhoi about a possible joint venture. "We all dream of developing a supersonic, we have the right skills, some customers are asking us for such an aircraft," Trappier said, adding "I cannot predict the future, but today we are not investing."

▶ **AVIATION WEEK NETWORK HOSTED ITS 62ND ANNUAL** Laureate Awards honoring extraordinary achievements in the global aerospace arena March 14



Pratt & Whitney PW800 a G500

in Washington, D.C. The Grand Laureate in the business aviation division was awarded to Bombardier for its new Global 7500. Other winners in business aviation include Garmin International in the Electronics/Avionics division; Mark Baker, president and CEO of the Aircraft Owners and Pilots Association for Leadership; the Bombardier Global 7500 for Platform; Gulfstream Aerospace for MRO; the Pratt & Whitney Canada PW800 for Propulsion; GE Aviation Catalyst Additive Manufacturing for Supplier Innovation; and Gulfstream's Runway Overrun Awareness and Alerting System for Safety.

► **TAG FARNBOROUGH FBO DOES IT ALL AND MORE**, as might be expected of a facility located on an airfield that bills itself as “a business aviation airport that is unlike any other private airport in Europe, offers unparalleled FBO services and amenities for passengers, crew and aircraft.” The FBO is on the east side of TAG Farnborough Airport, less than an hour drive southwest of London. Both share a common DNA with parent company and global aviation services provider TAG Aviation. Arrival by air begins with dedicated passenger and crew concierge service, as well as aircraft onboard customs and immigration service. The FBO features a private passenger lounge on the top floor with amenities including shower facilities and meeting rooms with Wi-Fi and internet access. Arriving by car, departing passengers are permitted direct ramp access to their aircraft, and passenger and



baggage security screening, if necessary, is quick and convenient. For those arriving by personal vehicle, there is private parking, including electric automobile charging stations, as well as Tesla-specific charging stations. Aware that more and more passengers are traveling with pets, TAG has a dedicated Pet Travel Scheme Support officer. Liz Shickle is a qualified veterinarian

and has been involved in TAG’s pet services program since it was launched in 2000. The aim is to simplify the journey of pets in and out of TAG Farnborough Airport and it is Shickle’s goal to meet every pet – cat, dog or ferret – that travels into and out of Farnborough to ensure it experiences a seamless journey. Advance notification of arrival or departure with pets may be made online to lshickle@tagfarnborough.com. Aircraft crews have most definitely not been forgotten at TAG Farnborough. Purpose-built crew facilities are located within the main terminal building and include a gymnasium, laundry service and crew showers, as well as snooze rooms that feature reclining chairs, flat beds, massage chairs, and blankets. The lounge also offers complimentary Wi-Fi, satellite television and refreshments. The FBO also has a café operated by inflight caterer Absolute Taste. Passengers and crews spending a night in Farnborough may take advantage of the four-star Aviator Hotel, just a 5-min. drive across the airfield from the FBO. Also owned by TAG Aviation, half of the 168 rooms offer views of the airfield, definitely a plus during the biennial Farnborough International Airshow. TAG Farnborough FBO is experiencing approximately a 7.4% year-over-year increase in aircraft movements and handles some 25,000 flights a year.

► **EAGLE JET SOLUTIONS HAS ACQUIRED FRONT RANGE AVIATION** at Great Falls International Airport in Montana and is changing its name to Great Falls Jet Center. The FBO will continue to provide aircraft management, aircraft sales and acquisitions, aircraft storage services, fuel services, crew cars, catering and other services. It also is expanding its service offerings and constructing a new 40,000-sq.-ft. hangar.

► **MILLION AIR WHITE PLAINS HAS OPENED A NEW FBO FACILITY** at Westchester County Airport in White Plains, New York, in a \$70 million project. The facility includes 6,865 sq. ft. of indoor valet space, a 22,000-sq.-ft. terminal, 50,400-sq.-ft.-hangar with heated floors and upgraded ramp facility.

► **ROSS AVIATION HAS COMPLETED ITS ACQUISITION OF RECTRIX** Aviation. Founded in 2005, Rectrix serves New England and Florida with five FBOs located in Boston (BED), Worcester (ORH), Westfield (BAF) and Hyannis (HYA), Massachusetts, as well as Sarasota, Florida (SRQ). It also operates an FAR Part 135 air charter and management business and has MRO facilities in Westfield and Sarasota. Retrix Aviation will retain its name.

Florida Jet Center Adds U.S. Customs



Stuart Jet Center in Stuart, Florida, has added a U.S. Customs facility to streamline international travel. The 3,210-sq.-ft. facility is located at Witham Field. Visitors no longer have to travel to Fort Pierce or West Palm Beach, Florida, for customs clearance. The FBO recently opened two 25,000-sq.-ft. hangars and 11,000 sq. ft. of office and shop space.

Avflight Acquires Kelly Western Jet Center



Avflight Corp. has expanded into Canada at the Winnipeg James Armstrong Richardson International Airport by acquiring Kelly Western Jet Center. It is Avflight’s first venture into Canada and is the company’s 21st full-service FBO in North America and Europe. Avflight Winnipeg offers customs, 24-hr. service, fueling services, deicing, courtesy cars and charter handling. Customers, transient traffic and staff at the FBO will experience a seamless transition, the company said.



Chad Cundiff

President
Astronautics Corporation of
America, Milwaukee, Wisconsin

After earning an engineering degree from the University of Kansas, Cundiff went on to collect a Master of Science degree in aeronautical engineering from the University of Washington and an MBA from the University of Missouri. He began his career as an engineer at Boeing, helping develop the 777. Then it was on to Honeywell where he spent over 15 years in various positions, eventually rising to vice president of crew interface products, responsible for Honeywell's display, terrain warning and flight management systems, winning the company's Top Performer award, along with earning two patents. He then led strategy and business development at UTC Aerospace Systems before his current appointment in 2013. He is also an ATP-rated pilot and a CFI with several thousand hours of flight time.



TAP HERE in the digital edition of **BCA** to hear more from this interview or go to aviationweek.com/fastfive

Questions for Chad Cundiff

1 Your company is a going concern in the avionics field, but is unfamiliar to many operators. Why?

Cundiff: We were founded 60 years ago in a one-room storefront by Nate Zelazo and Norma Paige. Sadly, Nate, our chairman emeritus, passed away this past November at the age of 100. We're quite successful and employ 1,400 people at Astronautics and at Kearfott Corp., a subsidiary. Astronautics is well known by vertical-lift OEMs and we are on many air transport and military platforms. The commercial business is divided between airlines and helicopters with some tier-two activity in business aviation. We don't deal directly with business jet operators but have been growing our engagement with helicopter operators. The rotary-wing segment is a big focus for us. We've been investing heavily in that market for several years now. We're a long-term believer in the vertical-lift segment, which we see as a growth market.

2 FAA contracted with you to assess system vulnerability to cyberhacking. What have you learned?

Cundiff: There are lots of open questions still. After all, how do you evaluate the whole electronic world of aviation including air traffic control, onboard systems and communications? Aviation has natural protections from being hacked, but if you really understand those, there's opportunity for trouble. Don't assume the danger is someone trying to defeat your flight control system. Aircraft today are connected. They're transmitting information all the time and that's a big issue. Moreover, hackers can see into your aircraft's cabin connectivity system and retrieve proprietary business information. Remember, Target got hacked through its HVAC system. The hacking threat is real. There are bad actors out there and people need to take that seriously. We have secure, connected aircraft systems to deny those attempts. For us, cybersecurity is core.

3 You're headquartered in Milwaukee, a long way from places closely identified with digital tech. Has that been a problem?

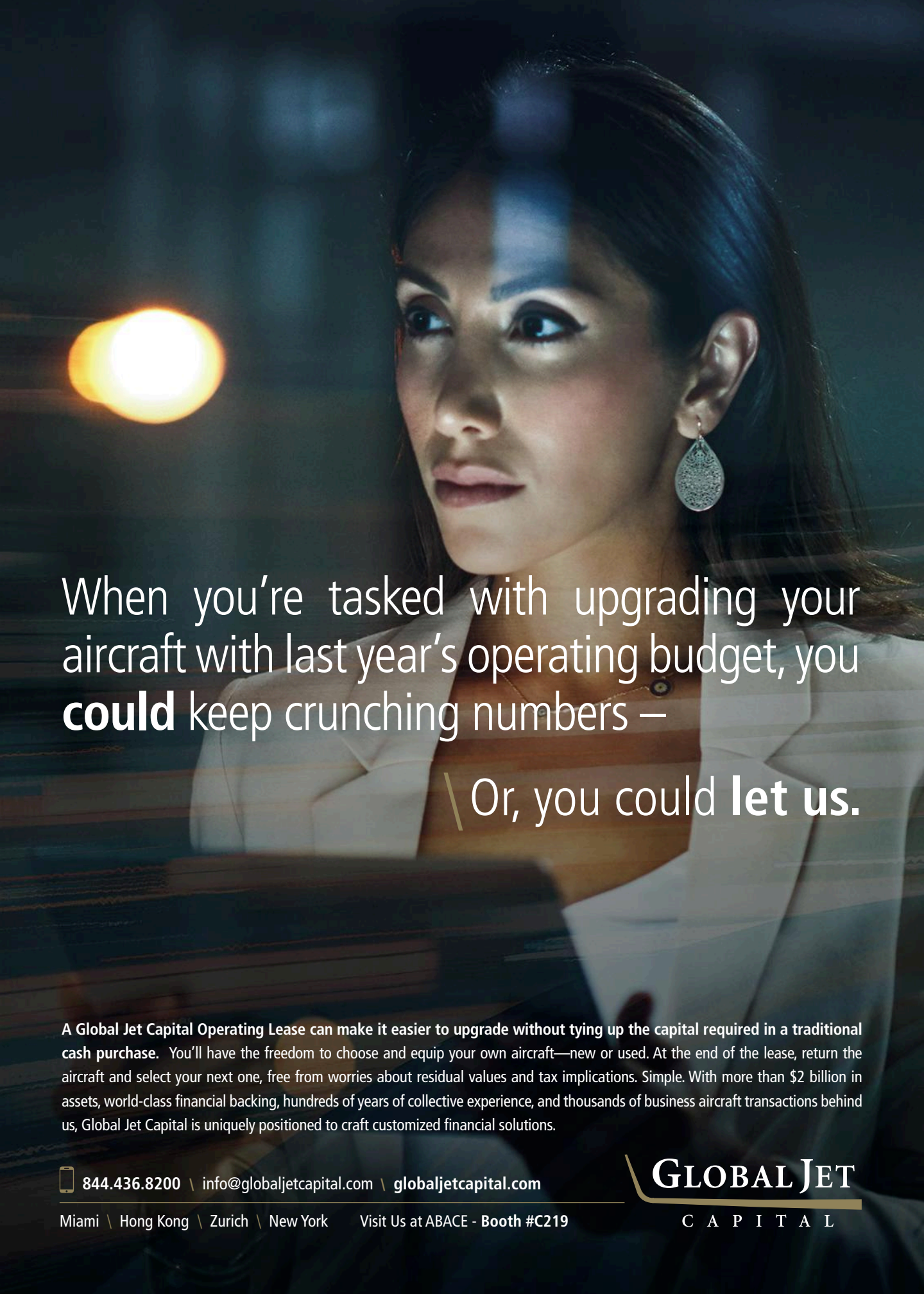
Cundiff: Silicon Valley has no lock on technology talent. We have no trouble attracting some of the best. Milwaukee has three major universities with strong engineering programs: Milwaukee School of Engineering, Marquette University and the University of Wisconsin-Milwaukee — plus, there's the main University of Wisconsin campus in Madison and Michigan Tech in Houghton, Michigan. The science and engineering grads from those schools, among others, are terrific and help keep us innovative and in the avionics forefront. Thanks to them and to the rest of our team, we develop products faster than our competition.

4 But you're moving.

Cundiff: Yes, but locally. We love Milwaukee. We're moving 17 mi. south from our current headquarters to a 150,000-sq.-ft. facility. The move allows us to consolidate our engineering, manufacturing and administrative functions in a single location that will facilitate product development and enhanced customer responsiveness. In addition, the new headquarters is close to Milwaukee Mitchell International Airport, which makes travel easier. Eventually, all our 450 Milwaukee associates will be centrally located in the new building.

5 Your products range from displays and communications to control. What are your lead lines?

Cundiff: We have three electronic flight instrument display families: RoadRunner, which is a quick, one-day drop-in digital replacement for 5-in. electromechanical displays, primarily for the helicopter market. It requires no changes to the panel and is lighter than the analog boxes it replaces. Second is Ibex, a lightweight, passively cooled semi-smart display product line. And then there's our fully integrated Badger system, which provides a complete flight deck for OEM and retrofit trainers, transports and helicopters. We're launching a third generation of Badger with lots of video capabilities, open interface architecture and touchscreen capability. We also leverage building blocks from those displays to create customized systems to satisfy unique customer requirements. Some of the big avionics players don't like tailoring; we do. We have several offerings in the connected aircraft space, from our soon-to-be-certified AGCS, which will be standard with Airbus helicopters, to the Boeing 787 EFB and the A400M Network Server System. We are focused on transporting, displaying and securing information wherever you need it. **BCA**



When you're tasked with upgrading your aircraft with last year's operating budget, you **could** keep crunching numbers —

Or, you could **let us.**

A Global Jet Capital Operating Lease can make it easier to upgrade without tying up the capital required in a traditional cash purchase. You'll have the freedom to choose and equip your own aircraft—new or used. At the end of the lease, return the aircraft and select your next one, free from worries about residual values and tax implications. Simple. With more than \$2 billion in assets, world-class financial backing, hundreds of years of collective experience, and thousands of business aircraft transactions behind us, Global Jet Capital is uniquely positioned to craft customized financial solutions.

844.436.8200 \ info@globaljetcapital.com \ globaljetcapital.com

Miami \ Hong Kong \ Zurich \ New York

Visit Us at ABACE - Booth #C219

GLOBAL JET

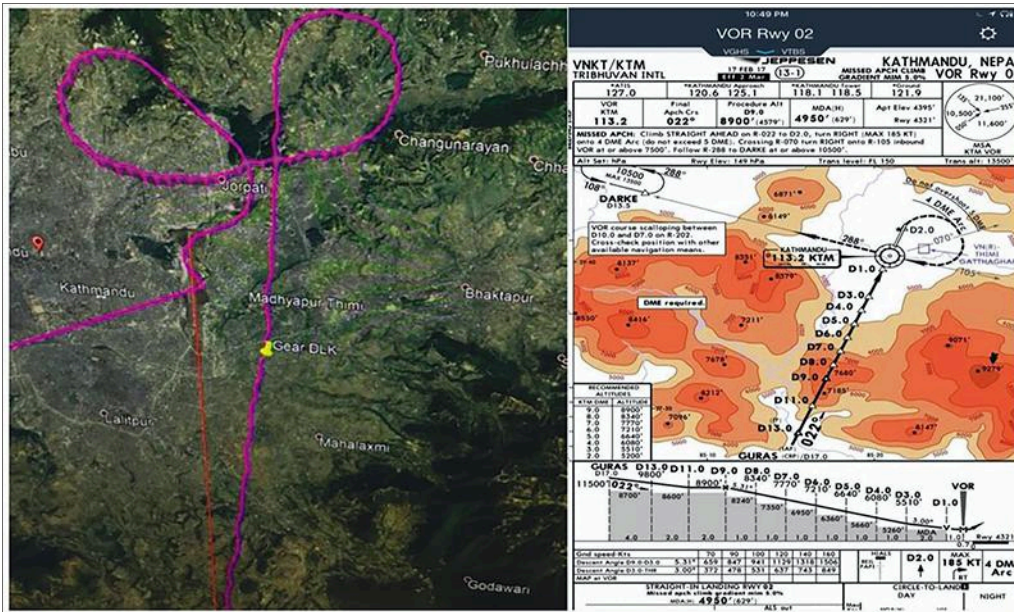
C A P I T A L



Distracted, Disoriented and Wrongly Determined

An approach so awful, the tower controllers ducked out of fear

BY **RICHARD N. AARONS** bcasafety@gmail.com



not been briefed by his company about the requirement for an ADC number, so radio discussions ensued between the pilot, company ops and ground control.

Investigators later stated that the pilot's vocal pitch and language during these exchanges indicated "he was agitated and experiencing high levels of stress."

During the climb-out, the captain overheard a radio communication between company operations and another US-Bangla aircraft regarding the fuel onboard that flight. The Commission stated the captain engaged in unnecessary

Four crewmembers and 47 of the 67 passengers on board a US-Bangla Airlines Bombardier DHC-8-402 (Q400) died on March 12, 2018, when their scheduled flight crashed and burned at Tribhuvan International Airport (VNKT), Kathmandu, Nepal, while maneuvering for a VFR landing.

The Nepalese government convened an investigation commission (NAIC). The Commission's findings are unusual and worthy of consideration:

The probable cause of the crash, said the Commission, was "disorientation and a complete loss of situational awareness" on the part of the pilot. Contributing to this was his attempt to recover from a misaligned approach path by maneuvering "in a very dangerous and unsafe attitude."

The landing "was completed in a sheer desperation" after the pilot sighted the runway at very close proximity and low altitude. He made no

attempt to go around, even though a go-around was possible until "the last instant before touchdown on the runway."

In short, psychological factors pushed the pilot to put the airplane on the ground regardless of how it got there, while steep experience and authority gradients prevented the copilot from intervening. What follows is largely from the Commission's report.

US-Bangla Airlines Flight BS211 was a scheduled segment from Hazrat Shahjalal International Airport (VGHS), Dhaka, Bangladesh, to Tribhuvan International. The aircraft would overfly Bangladesh and Indian airspace en route to Nepal.

Ten minutes before the 0651 UTC takeoff, Dhaka Ground Control contacted the aircraft requesting its Bangladesh Air Defense Clearance (ADC) number — a recently imposed mandatory filing for all international outbound flights. The captain had

radio conversation with the operations staff without verifying whether the fuel message was meant for him.

According to the investigation, "The pilot's vocal pitch and language used indicated that he was very much emotionally disturbed and experiencing high level of stress."

The 52-year-old male pilot in command held an ATP with ratings in the Dash-8-400 and the ATR 72. He had accumulated 5,518 hr. total flying time with 2,824 hr. in type and 667 hr. in the previous year. He had 15 hr. of rest before the accident flight. He served as a company instructor and check airman. He started his career in the military flying MiG fighters. In civilian life he flew commercial cargo operations and ultimately ended up with the passenger airline.

The 25-year-old copilot held a commercial license with experience in the Cessna 150 and a type rating in the Dash-8. She had accumulated a total of

FlightSafety is Here For YOU



Your Success

Relax. Our instructors work to ensure YOU have an exceptional training experience with a positive outcome.

Your Proficiency

Be the very best. We are committed to helping YOU achieve and maintain the highest level of skills and safety.

Your Satisfaction

Count on us. We all have the same goal: providing YOU with the highest-quality training and outstanding service.



Train with FlightSafety and benefit from our unequalled experience, team of master instructors and safety-focused programs using state-of-the-art simulation technology. Trust that we'll always go above and beyond for you and your flight department and deliver the value you deserve and expect. It's all about you.

FlightSafety
international

flightsafety.com • 314.785.7815

Cause & Circumstance

390 hr., 240 hr. in type and 131 hr. in the previous 90 days. Her rest period was “within limitations.”

Throughout the flight, said the Commission, the captain engaged in a lengthy one-way conversation with the first officer “and made multiple unnecessary statements and comments against another colleague in the company who had questioned his reputation as an instructor.”

The Commission reviewed the CVR transcript and concluded, “The captain seemed very much emotionally disturbed and stressed, because this conversation regarding the colleague was repeated several times during the flight. At times the captain even seemed to have an emotional breakdown . . .

personal issues and worries.”

At 0748:59, the first officer reported MONDA at FL 240 to Kolkata Control and was instructed to report establishing contact with Kathmandu Control. Between contacts, the captain was showing the first officer how to set up the FMS, FGS and other avionics. He did this “with great passion, calmness and professional efficiency,” said the Commission. The captain then asked the first officer if she was comfortable with all he had explained, and she replied, “Yes, very comfortable, sir.”

The Commission said it believes “that the captain was constantly trying to prove his professionalism and reputation as a competent trainer in front of a junior trainee during this flight.”

aircraft to descend to 11,500 ft., and cleared it for the VOR RWY 2 approach, maintaining minimum approach speed.

Neither pilot remembered to cancel the HOLD previously entered into the FMS because they were still engaged in unnecessary conversation. Upon reaching GURAS, the aircraft turned left to enter the holding pattern. The captain noticed the excursion and made an immediate correction. (ATC was alerting the crew to the situation at the same time.) The captain selected the HDG mode and dialed in a heading of 027 deg. — a 5-deg. intercept angle for the desired 202-deg. inbound radial to VNKT. The local wind was out of the west at 28 kt. The aircraft continued the approach in heading mode and crossed the 202-deg. radial at 7 DME. The aircraft then continued on the 027-deg. heading, thus deviating to the right (east) of the final approach course.

Although VMC prevailed, the crew never saw the airport as they passed it,

At 0832, the tower cleared US-Bangla BS211 to land on either Runway 2 or 20, but the aircraft again made an orbit to the right.

ending up 2- to 3-nm northeast of the complex. At 0827, Kathmandu Tower alerted the crew that the landing clearance was for Runway 2, but the aircraft seemed to be circling to Runway 20.

A minute later, the tower controller asked the crew of their intentions, to which the captain replied the flight would be landing on Runway 2.

The aircraft then made an orbit to the right. So, the controller instructed the crew to join downwind for Runway 2 and report when sighting a Buddha Air aircraft that was on final for the runway.

However, instead of joining the downwind leg for Runway 2, the US-Bangla Q400 continued its right turn to a westerly heading northwest of Runway 20. The controller instructed the aircraft to remain clear of Runway 20 and continue to hold at its present position because a Buddha Air aircraft was landing at Runway 2 (from the opposite side) at that time.

At 0832, the tower cleared US-Bangla BS211 to land on either Runway 2 or 20, but the aircraft again made an orbit to the right.

While continuing with the turn, the captain reported that he had the runway in sight and requested clearance to land. The tower controller cleared the aircraft to land. The aircraft continued



This stress might have led him to smoke in the cockpit during the flight and this clearly was against the company SOPs. This state of mind with high degree of stress and emotions might have led him to all the procedural lapses that followed . . .

“The captain was trying to perform his role as pilot flying and instructor coaching the first officer on various aspects of flying and operations environment in VNKT. These factors might have escalated his flight duty workload even further.”

The first officer was performing her flight duties on this route for the first time. The captain was familiar with the sector but had been in Ethiopia for training over the previous 24 days.

A full analysis of the approach is presented later, but here are the highlights:

At 0746:27, the crew began to prepare for its arrival into the VNKT area. While monitoring ATIS and performing other flight duties, said investigators, the pilots were busy “discussing their

At 0752:04, the aircraft made initial contact with Kathmandu Control. At 0807:49, the first officer requested descent clearance, and Kathmandu cleared the aircraft to FL 160 with an estimated approach time of 0826, which she acknowledged.

At 0810, the flight was handed off to Kathmandu Approach, and a minute later the approach controller instructed the aircraft to descend to 13,500 ft. and hold over GURAS (17 nm southwest). The crew inserted the GURAS hold in the FMS.

The reported weather at the time was VFR — 6,000 meters visibility; wind, 210 deg. at 6 kt.; few clouds at 1,500 ft.; scattered clouds at 3,000 ft.; temperature, 22C; and dew point 10C. Elevation of Tribhuvan Airport is 4,390 ft. Its single runway — 2/20 — is 10,007 ft. long. MDA on the approach is 5,120 ft. (807 ft. AGL).

ATC instructed the aircraft to reduce speed and descend to 12,500 ft. Three minutes later, Approach instructed the

to turn and approached very close to the threshold of Runway 20 on a westerly heading and unaligned with the runway.

At 0833:27, the tower controller became alarmed by the situation and canceled the landing clearance by saying, "Takeoff clearance canceled." (He obviously misspoke.)

Within the next 15-20 sec., the aircraft pulled up in a westerly direction and turned left with a very high bank angle and overflew the western area of the domestic apron, continued on a southeasterly heading past the control tower and continued at a very low height over the domestic southern apron area and finally attempted to align with Runway 20 to land. (While the aircraft was heading toward the control tower, the controllers ducked out of fear that it would hit the tower building.)

"When the aircraft further turned toward the taxiway aiming for the runway through a right reversal turn, the tower

The Commission concluded that most of the occupants would have survived the impact, but the immediate and rapidly spreading post-crash fire likely precluded the possibility of escape.

controller made a halfhearted transmission by saying, 'BS211, I say again . . .,'" said the Commission.

At 0834, the aircraft touched down 1,700 meters from the threshold in a 15-deg. bank at a 25-deg. angle to the centerline. It then veered southeast off the runway through the inner perimeter fence along a rough downslope and finally stopped about 442 meters southeast of the touchdown point. The aircraft broke up into number of sections along the rough downslope before coming to a stop.

Some 2,800 kg (6,200 lb.) of fuel was on board at touchdown; fire broke out within 6 sec. The Commission concluded that most of the occupants would have survived the impact, but the immediate and rapidly spreading post-crash fire likely precluded the possibility of escape for most of those who died. The airport fire brigade vehicle movement was initiated within 16 sec. of impact.

Commission Analysis

Investigators looked to the CVR transcript to understand the final moments of the flight. The captain was flying throughout the approach and also

communicating, thus increasing his workload.

At 0758:24, the captain told the first officer how to locate charts for the VNKT arrival. The Commission believes that the captain did not have the proper charts in view at this time and that fact "could be interpreted as an indication that he was not adequately prepared for flight operation at that time." Hence, the captain made a very short briefing on the arrival into VNKT while referring to the first officer's charts.

"The captain never carried out a complete briefing on VNKT RWY 02 approach, which requires a very high degree of flight deck preparation, orders and understanding of the very challenging operations environment. This

rate requirements, aircraft configuration schedule, speed control, stabilization criteria, missed approach point and procedure, minimum descent altitude and runway lighting etc. were never reviewed.

"In summary," said the Commission, "the flight crew failed to conduct a complete approach briefing. The briefing they did conduct was unstructured and inconsistent. The first officer also made several statements that indicated she had an incorrect understanding of the procedures to follow during approach. Her confusion over the missed approach procedure was never resolved by the captain, asserting that he would brief the remaining items later.

"The Commission concludes that as



might indicate his complacency as he had performed this approach several times before and did not realize that the first officer was operating this flight for the first time."

At 0759:05, the crew used the first officer's charts to review the ROMEO STAR and several waypoints with altitude restrictions and the track to follow toward GURAS, the IAF. The crew failed to review the more important and complex approach chart in detail and conducted only a "very brief discussion" mentioning the procedure altitude of 8,900 ft. at 9 DME and the obstacle clearance altitude for that particular segment of approach.

The captain directed the first officer to clip the approach charts on her side console, so he had no means of referring to the chart again while performing the approach as the pilot flying. Critical items such as minimum sector altitudes, final approach inbound course, type of approach, surrounding terrain with highest obstacle sectors, descent

a result of the flight crew's failure to complete the approach briefing as per the company SOPs, the captain and the first officer did not have a shared understanding of how the approach was to be managed and conducted. Both pilots failed to recognize their lack of compliance to prescribed procedures and threat identification techniques."

Final Moments

The first officer reported GURAS at 11,500 ft. to ATC at 0821:06. The flight was cleared to continue. "This particular moment becomes the triggering factor for distraction and temporary confusion between the crew when the aircraft suddenly started entering the hold over GURAS as programmed in their FMS," said investigators.

The pilots were surprised because they had not removed the HOLD instruction. The captain hurriedly selected the HDG mode to 027 deg. to intercept the final approach inbound

track, thus overriding the autopilot FMS LNAV guidance. This action on the FGCP caused the loss of FMS Auto Flight Final Approach lateral navigation guidance capability.

The ADC registered strong westerly winds from 270 deg. to 280 deg. at an average of 28 kt., pushing the aircraft flight path toward the east.

The flight was now high on the vertical descent profile. (The captain was distracted, and the aircraft had gone to pitch hold mode reversion due to heading selection in HSI.)

The captain commanded descent inputs in the FGCP pitch wheel to approximately 1,300 fpm to initiate descent.

Per the airline's SOPs for stabilized approach criteria, the airplane should have been in full landing configuration at this time with the landing checklist completed.

The captain requested initial flaps 5 at 15 DME after crossing the IAF. At 0822:5, the captain asked for flaps 15 and the landing checklist while crossing 13 DME. During the landing checklist challenge and response sequence, the captain confirmed the landing gears were down by stating "gears down three greens" without checking to confirm their position. Actually, the gears were not down and locked. This was

overlooked by the first officer as well.

At 0823:41, the first officer reported to ATC that the flight was on a 10-mi. final; the CVR recorded the landing gear unsafe tone sounding continuously and ignored by both pilots.

At 0823:45, the flight was handed off to VNKT Tower and initial contact with the tower was established at 0824:39. The flight was cleared to continue the approach, and the gear unsafe tone continued to sound in the cockpit.

At 8 DME, the captain erroneously set the minimums at 4,688 ft. instead of 4,950 ft. as published. (The radio altimeter was set to 629 ft. to receive the "100 ft. above" auto-callouts above the correct minimums.)

The captain requested the landing checklist again and the first officer affirmed that it had already been completed even though the landing gear unsafe tone was still active. During the final descent, the first officer called out the altitude constraints for the segments and kept prompting the captain that they were 500 ft. to 600 ft. high on profile.

"With the noisy flight deck — the landing gear unsafe tone was active — and in an already rushed situation where the crew was dealing with correcting a significant vertical flight path

deviation, the pilots seemed so preoccupied that the interception of the final approach course of 022 deg. by the aircraft in HDG mode at 7 DME went undetected by both pilots and hence the flight path deviation started toward the east of final course. No attempt was made to rearm or reengage the FMS LNAV mode or select the VOR mode," said the Commission.

The CVR revealed that the captain was having difficulty in understanding what the first officer was saying due to the high noise levels inside the flight deck. Exhibiting his confirmation bias, the captain again requested the landing checklist for the third time, where the first officer again confirmed that it had already been completed regardless of the landing gear unsafe tone still stridently audible.

At 0825:25, the aircraft arrived at the MAP in VMC with a descent rate near 1,700 fpm and the aircraft well east of the final approach course. The EGPWS announced "Sink Rate" and "Too Low Gears" callouts. The tower reported winds from 220 deg. at 7 kt. with a tailwind component of 6 kt. and cleared the flight to land on Runway 2.

No attempt was made by the flight crew to carry out a standard missed approach procedure, regardless of the

Accidents in Brief

Compiled by Jessica A. Salerno

Selected accidents and incidents in February 2019. The following NTSB information is preliminary.

► **February 23 — About 1243 EST, a** STOL Aircraft Corp UC-1 amphibious airplane (N65NE) crashed into a residence shortly after takeoff from Winter Haven Regional Airport (GIF), Winter Haven, Florida. The flight instructor was killed, the commercial pilot receiving instruction sustained minor injuries, and there was one serious ground injury. The airplane was owned by ESP Aviation LLC and privately operated under Part 91. It was VFR and no flight plan was filed for the local instructional flight that departed at 1239. According to the commercial

pilot receiving instruction (the pilot), he and a colleague were receiving initial airplane multiengine sea training from the flight instructor in the accident airplane. The accident flight was the third flight of the day.

According to the pilot, the instructor advised him before takeoff that he would introduce a simulated engine failure at some point during takeoff or climbout. Shortly after takeoff from Runway 23, about 200-300 ft. AGL, the instructor reduced the throttle on the left engine and the left engine stopped producing power, and the propeller feathered. They identified the failed engine, the instructor took over the flight controls, and selected a forced landing site.

During the descent, the flight crew's engine restart procedures were unsuccessful and they determined that the airplane would not reach the selected forced landing site. The instructor then chose a lake to the airplane's left as an alternate site. During the left descending

turn, the airplane slowed, the left wing dropped, and the airplane impacted a house, seriously injuring one of its occupants.

The pilot held a commercial pilot certificate with ratings for airplane single engine land, airplane single-engine sea, and instrument airplane. He held a flight instructor certificate with a rating for airplane single-engine. His most recent FAA second-class medical certificate was issued Oct. 24, 2017. He reported 820 total hours of flight experience on that date.

The flight instructor held an airline transport pilot certificate with ratings for airplane single- and multiengine land, and single- and multiengine sea. He held a flight instructor certificate with ratings for airplane single- and multiengine. His most recent FAA first-class medical certificate was issued Jan. 25, 2019. He reported 15,000 total hours of flight experience on that date.

The five-seat, twin-engine, high-wing,

fact that they had not identified the airport environment, nor had they met the stabilization criteria for IFR operations. (The pilots had good visibility of the ground environment, but had not located the airport.)

At this point the first officer realized the landing gear was not down and initiated its extension under the instruction of the captain. The captain requested the landing checklist for the fourth time. Further conversation between the pilots “led to an ambiguous expectation of when they would acquire visual contact with the runway environment.” By this time, the aircraft had already flown past the eastern side of the runway and was northeast of the airport. The captain continued to assume that the landing runway was ahead of them, though it was now behind them. Autopilot was disengaged at 1.1 nm east of the VOR.

At 0827:30, a VNKT tower trainee controller contacted BS211 seeking the crew’s intentions. Noting that the airplane had passed Runway 2, the controller issued a clearance to land on Runway 20. The captain replied that he thought he was continuing for Runway 2.

At this moment the tower trainee controller was replaced by the tower duty controller. Based on the airplane’s

visual flight position northeast of the airport, he cleared the flight to land on Runway 20 believing that was the pilot’s intention. Shortly thereafter, the duty controller was replaced by the tower supervisor.

While the crew struggled to find the runway, the flight continued northeast. The CVR recorded continuous EGPWS warnings with various flight parameters exceeded. At around 6 DME northeast of the VOR the captain started maneuvering the aircraft on a right-hand circle while sighting the rising terrain ahead of them. During the maneuver, the aircraft descended to as low as 175 ft. AGL with bank angles of up to 35 to 40 deg., triggering various EGPWS alerts and warnings.

“Desperate to find the landing runway and still unaware of their position, compounded by threatening high terrain all around and multiple EGPWS warnings,” said investigators, “there was a complete loss of situational awareness on the part of the flight crew at this stage.”

At 0829:02, VNKT tower asked the crew about their intention and tried to reconfirm the aircraft was still VFR. The captain affirmed and radioed his intention to land on Runway 2. Based on the aircraft’s current position, the

controller cleared the flight to join the right-hand downwind for Runway 2.

At this time, the tower also was handling another aircraft — Buddha 282 — which was on a 2-mi. final for Runway 2 and had been cleared to land. This traffic information was passed on to BS211, cautioning the pilots again that there was landing traffic on short final for Runway 2 sequenced before them. The disoriented Dash-8 captain acknowledged the report.

Rather than join the downwind as assigned, BS211 flew toward Runway 20. The tower controller warned BS211 not to proceed toward Runway 20 because of possible conflict with Buddha 282. Flight BS211 was cleared to perform an orbit at its current position. However, BS211 had already flown past the threshold of Runway 20 — 3.2 DME north of the VOR — on a heading of 280 deg. at 6,000 ft. The Dash-8 continued to climb to 6,500 ft. when the captain again started maneuvering the aircraft on a steep right-hand circle. He was constantly talking to the first officer and, at this time, admitted to her that he had made a mistake.

During this circle, bank angles reached up to 45 deg. with descent rates over 2,000 fpm triggering the EGPWS warnings again.

amphibious airplane was manufactured in 1986. A review of the airplane maintenance records revealed that a 100-hr inspection was completed on Feb. 23, 2019.

► **February 23 — About 1225 EST, a Cessna 172S (N244TA)** was substantially damaged when it impacted terrain, during a go-around at Mansfield Municipal Airport (1B9), Mansfield, Massachusetts. The flight instructor and student pilot were killed. The airplane was owned and operated by New Horizon Aviation Inc. under Part 91. It was VFR and no flight plan was filed for the local instructional flight that originated from Norwood Memorial Airport (OWD), Norwood, Massachusetts, about 1020.

After performing maneuvers over the local area, the airplane approached 1B9 for landing. Witnesses and a review of airport surveillance video revealed that the airplane was on approach to Runway 32, a 3,503-ft.-long, 75-ft.-wide,

asphalt runway. The airplane remained in the landing flare over approximately 2,800 ft. of runway before a go-around was initiated. Although the airport traffic pattern for Runway 32 required left turns, the airplane performed a climb in a steep right bank, before slowing and descending in a spiral toward a grass area near the terminal building.

The wreckage came to rest nose down in grass, oriented about a magnetic heading of 270 deg., and no debris path was observed. Fuel had leaked out of both wings and into the grass. Both wings exhibited leading edge impact damage. The cockpit was crushed, but both front seatbelts remained intact and were unlatched by rescue personnel. The flaps and ailerons remained attached to their respective wing and measurement of the flap actuator corresponded to a flaps retracted position. The rudder and elevator remained attached to the empennage and measurement of the elevator trim actuator corresponded to

a 5° tab up (nose down) trim position. Control continuity was confirmed from all flight control surfaces to the cockpit controls. The right aileron cable had separated and both cable ends exhibited broomstraw separation.

The four-seat, high-wing, fixed tricycle landing gear airplane, was manufactured in 2002. and its most recent annual inspection was completed on January 29, 2019. At that time, the airframe had accrued 5,660 total hours since new and the engine had accrued 3,358 hr. since major new.

► **February 22 — About 0955 CST, a Beech 65 (N62069)** crashed near Colby, Kansas, while maneuvering for a precautionary landing. The commercial pilot was not injured but the airplane was heavily damaged. The Beech was registered to and operated by Bemidji Aviation Services, Inc., as a Part 91 positioning flight. Day instrument meteorological conditions prevailed at the time of the accident,

Cause & Circumstance

While the Dash-8 was maneuvering, the CVR recorded another local pilot from the ground raising concern to ATC that the Dash-8 pilots seemed to have been disoriented and lost and also informed ATC that the surrounding visibility toward nearby hillsides was marginal. The airport visibility at this time was still 6,000 meters. Until this moment the CVR recorded no statements from either Dash-8 pilot that they had located the runway although they were maneuvering in the vicinity of the Runway 20 threshold.

At 0831:52, the tower issued a landing clearance to the flight for either runway. The Buddha Air flight had landed and was clear of the runway.

The captain replied that he would like to land on Runway 20 now although neither pilot had the runway in sight. The aircraft now exited the orbit and flew to the southwest on a heading of 160 deg. at an altitude of 5,400 ft.

“Both pilots were anxiously trying to locate the runway,” said investigators. “The CVR revealed the pilots made several statements which reflected that they had now completely lost their orientation of the runway, but this was not communicated to ATC.”

At 0832:34, the flight was just northeast and abeam of the threshold of

Runway 20 on a southeasterly heading. The tower controller advised the crew “to turn right” in an attempt to assist the pilots find Runway 20.

At 0832:43, the first officer sighted the threshold of Runway 20 at their three o'clock position. The airplane was at 5,500 ft., some 4.1 DME from the VOR and approximately 1.8 nm from the threshold of Runway 20.

“Though it appeared unmanageable to land the aircraft on Runway 20 from that current position, attitude and altitude, for some undetermined reason, the captain initiated desperate maneuvers in an attempt to put the aircraft on ground and requested landing clearance again affirming that he had the runway in sight now,” said the Commission. “The flight directors were set to standby at this point and the captain reconfirmed the landing checklist was done again for the sixth time now. Still to his confusion he requested the first officer to give him the heading bug of 022 deg. and set the same on her side, though the practical setting would have been 202 deg. for Runway 20.

“The FDR data shows that the aircraft overflew the threshold of RWY 20 at 450 ft. AGL on a westerly heading of 255 deg. and left bank angles of 40 deg. at an IAS of 150 kt. Distressed and

panicked by the captain's engagements, the first officer made no callouts for go-around or to discontinue the maneuver.

“At 0833:27, spotting the aircraft carrying out reckless and irresponsible maneuvers at very close proximity of the ground within the airport periphery and alarmed by the situation, the tower controller hastily canceled the landing clearance by saying ‘Takeoff clearance canceled.’ At that critical moment ATC was confused sighting the unusual and abnormal maneuver of the aircraft and could not be assertive. The captain still requested a clearance in a calm and content tone. But the aircraft was flying on improper attitude.”

The EGPWS warnings “Bank Angle” and “Sink Rate” sounded continuously in the cockpit while the aircraft overflew the airport's domestic apron, and cleared the hangar side and domestic passenger terminal by barely 45 ft.

Tower controllers viewed all the airplane's “unusual maneuvers . . . and out of fear, ducked down below their table level.”

The airplane missed the tower and overflew the parking area before making a right reversal turn to align more or less with the runway. The Dash-8 impacted on its right main landing gear 1,700 meters past the Runway 20

Accidents in Brief

and an IFR plan was filed. The flight was originating from Shalz Field Airport (CBK), Colby, Kansas, at the time of the accident and destined for Denver, Colorado. According to the operator, shortly after takeoff, the pilot noticed the crew door, located next to the left front seat, had inadvertently opened. The pilot initiated a precautionary landing back to CBK. While maneuvering at a low altitude to stay in visual flight rules conditions (overcast ceiling at 200 ft.), the airplane stalled and impacted the terrain with the landing gear retracted. Post-accident examination of the airplane revealed the left wing and left aileron were bent.

► **February 21 — About 1045 EST, a**

Beech 76 (N7KY) crashed during an aborted landing at Capital City Airport (FFT), Frankfurt, Kentucky. The commercial pilot was not injured, and a flight instructor incurred minor injuries. The airplane was substantially damaged. The Beech was operated by Nexgen Aviation LLC Part 91 instructional flight. It was VFR near the accident site, and no flight plan was filed. The flight originated at Blue Grass Airport (LEX), Lexington, Kentucky about 0910, and was destined for FFT.

According to the operator, the purpose of the flight was to prepare the pilot for an upcoming commercial multiengine check ride. After airwork in the local area, the flight proceeded to FFT for approaches and landings. The pilot set up for a simulated single engine landing on Runway 25. While over the runway for landing, the approach became unstable, and the pilot attempted a go-around. The airplane veered to the left and the left wingtip contacted the ground between

the runway and taxiway. The airplane then collided an embankment and came to a stop. A postaccident fire ensued, and the pilots egressed the airplane and were met by first responders.

► **February 21 — About 2005 EST, a** Piper PA-32R-301T (N4922K) registered to Ironhead LLC, Middlebury, Indiana, and operated by the pilot, was destroyed after it impacted high power lines and the ground while on a practice RNAV approach to the Goshen Municipal Airport (GSH), Goshen, Indiana. The commercial pilot, who was the sole occupant, was killed. Night VFRI conditions prevailed, and a flight plan was not filed. The personal flight was being conducted under Part 91. The local flight originated from GSH about 1950.

According to FAA records, the pilot had departed Runway 27 and contacted the South Bend departure air traffic control (ATC) facility. He requested local clearance to conduct a practice RNAV

threshold on the left side of the centerline. The aircraft hit the runway at an IAS of 127 kt. and a heading of 190 deg., and immediately departed the runway surface “in an uncontrollable manner, further impacting the inner periphery fence, descending downslope and finally bursting into flames.”

Psychological Aspects

Management and most fellow pilots opined that the captain was a very friendly, soft-spoken and gentle person. He was levelheaded, they said, and would behave nicely with his colleagues and junior staff. He was well-spoken and would not use foul language in conversations. His attitude and behavior toward company, authority, colleagues and juniors was good and he was liked by most of them. He was also a very good teacher and instructor. Most of the students were satisfied with his teaching techniques. The captain never consumed alcohol, was happily married and had a teenage son.

The Commission said it seemed the captain was obsessively worried over a female colleague’s criticism of his competency. Most of the conversation in the cockpit during the accident flight was directed toward and aimed at the

woman who apparently was telling others that the captain was not a good instructor and he could not teach properly.

“This talk seemed to hurt the captain very deeply as he really took pride in his teaching skills,” said the Commission. “He was telling the first officer about how this particular talk had hurt him a lot, so much so that though he loved the company and liked the environment around, he would give notice for resignation from the company because of the alleged behavior of the female colleague.

“The effect of stress was evident with the fact that he was irritable, tensed, moody and aggressive at various times,” said the Commission. He also seemed to be fatigued and tired due to lack of sleep the previous night as well as due to the stress he was harboring. “The captain’s impulsive and inappropriate behavior, or concentration, incomplete task management — as not completing the before-landing checklist, mentioning all three green for landing gear down in spite of not actually all three being green, repeatedly asking for before-landing checklist in an obsessive manner — was all due to the excessive stress he was harboring.

“The captain seemed very insecure about his future as he had planned to

resign from this company. He said he did not have any job and did not know what he was going to do for living in the future. The future financial insecurity may have augmented his stress.”

The captain was engaged in unnecessary conversation that was beyond the norms and violating the company SOPs, concluded the Commission. This distraction, as well as stress, may have led to an unstabilized approach, poor speed control, failure to correctly configure the aircraft and failure to assure the checklists were completed.

“He had many opportunities to correct the maneuvers, if he had followed the SOPs during the descent and approach phases,” said the Commission. “It seems that the captain was trying to prove to the first officer that he was indeed a good pilot, good teacher and competent in flying skills, and would be able to safely land the aircraft in any adverse situation.

“The captain’s decision to land the aircraft at any cost after sighting the runway at a very close proximity, way off the final approach course, at very low altitude, and the decision for not initiating a go-around even after realizing that flight was not stabilized, is very poor decision making on the part of the PIC.” **BCA**

(GPS) RWY 9 approach. His practice approach was intended to circle to land on Runway 27. According to preliminary radar data, the airplane was following the published RNAV approach inbound. The track showed the airplane turning south to initiate the circle to land on Runway 27. An eye witness reported that the airplane seemed to be aligned on a roadway, parallel to Runway 27 (the roadway distance from Runway 27 was approximately 3,000 ft.). Radar showed that airplane track was as the witness described. The witness described the airplane turning toward Runway 27. Radar contact was lost, and no distress calls were heard from the pilot. An airport security video showed what appeared to be the airplane flying toward the airport, a flash, and then the airplane disappeared. The video also recorded what appeared to be a ground explosion.

The wreckage was adjacent to downed 250-ft.-high power lines. Examination of the wreckage at the accident site showed

evidence of the airplane impacting the power line wires. Portions of the power line wires were found embedded around the propeller and wire marks were found on both wings.

► **February 15 — About 1715PST, a Cirrus SR22 (N917SR) was destroyed following impact with terrain while maneuvering at a low altitude, about 3.4 nm north-northeast of Ely Airport (ELY), Ely, Nevada. The private pilot and passenger received fatal injuries. The airplane was registered to and operated by the pilot under Part 91 as a personal flight. It was IFR at the time and no flight plan was filed. The flight originated from Craig-Moffat Airport (CAG), Craig, Colorado, about 1525 MST, and was destined for Twin Falls Regional Airport (TWF), Twin Falls, Idaho. Initial data reported by the FAA revealed that the pilot contacted the Denver Air Route Traffic Control Center about 1538. At that time the pilot was observed**

flying west-northwest bound for about 6 nm, then turned left and flew west-southwest bound; he then climbed to about 17,500 ft. MSL. At this time, the FAA controller questioned the pilot about his route of flight, as the airplane was not heading toward TWF, the destination airport. The pilot responded by saying that [he] was trying to stay away from areas of weather to the north. When the airplane was observed having started a descent from 17,500 ft., the controller instructed the pilot to maintain VFR) at or above 10,500 ft., which was due to an active military area he were transiting. The pilot acknowledged, but continued to descend below 10,500 ft, saying that he was trying to stay below the cloud deck. While the controller was able at this time to remain in contact with the pilot, radar contact was lost as the airplane descended below 10,000 ft.

The airplane’s wreckage was located the following afternoon, February 16, about 3.4 miles northeast of ELY. **BCA**

Bad Ideas

Aviation's two most dangerous words: **"watch this"**

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



IVAN BETANCOURT

The gear-up landing of Gulfstream G159 YV-08CP, Aug. 27, 1993.

There is no shortage of bad ideas out there, but the ones that concern me are old sayings that have a history of being wrong yet are still embraced by some pilots. Let's look at a few.

A common denominator seems to be that certain pilots absolutely believe that their procedures are safe, until they end up breaking something. At that point, they blame the airplane, their training or something else. I've had my share of bad ideas over the years. But once I recognize the error, I am the first to admit I screwed up, and then try to spread the word so nobody else falls for the same bad idea.

"Train like you fight, fight like you train" is a sound idea for a military flying unit where the job is to kill people and break things. But when you do that, the training losses usually exceed wartime losses. That has been true in the U.S. Air Force and Navy since the dawn of military aviation. But when you aren't fighting a war, it is a bad idea to play so close to the edge of safety in airplanes when you have high-quality simulators available.

My generation of Air Force pilots has been especially guilty of staying on the edge in training others. We had

simulators, but they were not very good. We didn't have as much access to them as necessary, and we got bored doing the same thing over and over. Then one day, somebody had the bright idea of pulling circuit breakers while flying airplanes.

When the 89th Military Airlift Wing flew the Lockheed JetStar (C-140), just about all of the training was conducted "in house" and instructors became creative about how to place their students under stress. The idea was to make the training as difficult as possible so that the mission itself became easy. Fair enough; the JetStar was practically bulletproof.

Bad Idea: CB Shenanigans

In the late 1980s when those aircraft were replaced with the Gulfstream GIII (C-20), the same cadre of instructors looked at ways to play the same training games. It didn't matter that they had access to very good simulators. So, we ended up cutting engines during takeoff, and failing all sorts of systems from before engine start all the way to landing. The most realistic way to fail many of the systems was by pulling the associated circuit breaker.

My last job at Andrews Air Force Base was as the wing's chief of safety, while also serving as a qualified C-20 pilot. We were having a rash of failures with the C-20's Electronic Flight Instrument System (EFIS). It seemed curious that the civilian version of the airplane didn't have these problems. And I knew that our instructor force delighted in pulling the EFIS circuit breakers to force the student to select alternate instruments or to fly the airplane using standby instruments.

Suspecting a connection, I managed to convince the wing to place a one-month ban on pulling EFIS circuit breakers. To the delight of the maintenance squadrons, our EFIS problems went away. After the ban was lifted, the circuit breaker pulling resumed, and so did the EFIS problems. The aircraft that later replaced the C-20 cannot tolerate these kinds of circuit breaker shenanigans, so the practice was finally dropped. (Or so I am told.)

If you are tempted to say a few avionics problems are a good price to pay for high-quality training, consider a Gulfstream of a much earlier vintage. In 1993, a G1 landed gear up at Simón Bolívar International Airport, Maiquetiá, Venezuela (SVM). From one of the local pilots: "The PIC was conducting a command upgrade check ride. They were configured for a flaps 0 landing on Runway 09 when ATC instructed them to join right downwind and land on Runway 26, a parallel runway. The examiner was known to pull CBs and disable warning systems as part of his check ride routine. Well, he disabled the gear horn warning [no idea why he would do such a thing], but when combined with fatigue, distraction, incredible foolishness and over-confidence the outcome was predictable."

Since those days, most manufacturers have become rather explicit about pulling and resetting circuit breakers.

To paraphrase a few manufacturers: The circuit breaker is not a switch. Don't pull them unless the checklist tells you to; don't reset them without fully considering why they had popped in the first place.

Bad Idea: Never Go Around Once the Gear Is Down



The result of a test pilot's decision to land the airplane rather than go around.

Around 1984, my Boeing 707 (EC-135J) squadron in Hawaii had a rash of flap problems that only became apparent after the gear was extended. This is actually a common trait of many airplanes: You can't get that last notch of flaps until the gear is extended.

We had a pilot run into this after being cleared to land on Honolulu International Airport's (PHNL) longest runway but to remain short of an intersecting runway. The pilot told tower he needed all of the runway and tower said he could either comply or go around. The pilot elected to land. He managed to stop prior to the intersecting runway, but all eight main gear tires exploded from the braking effort. The airplane was damaged and the runway was closed.

That pilot didn't want to go around and resequence himself into a busy pattern. He didn't want to declare an emergency because the airplane was perfectly landable if given the full runway. He somehow felt he was selecting the only option available to him. This feeling that landing is the only option isn't uncommon. On Feb. 14, 2011, a highly qualified Gulfstream production test pilot made a similar decision at Outagamie County Regional Airport, Wisconsin (KATW), heavily damaging a brand-new Gulfstream G550.

The hydraulic system on the G550 that provides pressure for the flaps, ground spoilers and wheel brakes failed on short final. The copilot asked, "Should we go around to check it out?" To this, the pilot flying said, "No . . . we're gonna land 'cause it's leakin'."

Experienced Gulfstream pilots know

the airplane doesn't "sit" on landing with the ground spoilers inoperative and endeavor to fly the airplane onto the runway. This pilot didn't touch down until 2,048 ft. down the runway, leaving 4,453 ft. to stop. It then took 8 sec. to lower the nosegear. The pilot deployed the right thrust reverser, but the left was inoperative because of the left hydraulic system failure. The pilots failed to extend the speed brakes. With only 3,000 ft. remaining, they discovered their wheel brakes were inoperative. At this point the emergency brakes could have stopped the airplane. The pilot instead attempted to abort the landing and take off.

Gulfstream tests show this would not have worked. Fortunately, the copilot pulled the throttles back, very likely saving their lives.

Why would a production test pilot make a series of mistakes that a novice pilot would have avoided? Sometimes confidence overpowers caution. Why would a highly experienced combat pilot make a procedural error a moderately experienced Gulfstream pilot would have gotten right? Sometimes non-applicable experience works against you. Why would a pilot trained in the pre-

airplane when something goes wrong after the gear is down, than it is to go around. He blamed his training but acknowledges today that he would have made a different decision given what he has learned since.

I have never been taught it is better to land than go around if I had a problem after the gear was down. I think this is probably true if you are on fire or if something bad happens and you've no doubt about the airplane's ability to stop. But if you insist on this idea, I urge you to consider a few exceptions:

- ▶ If any system needed to stop the airplane (spoilers, flaps, reversers, brakes, tires, etc.) is impacted.
- ▶ If anything happens that invalidates your planned landing performance calculations, such as a smaller flap setting, inoperative spoilers, inoperative reversers, anti-skid system failures, etc.
- ▶ If anything happens environmentally that impacts the runway, such as contamination or obstructions.

In other words, there are so many exceptions to this idea of not going around, so as to make it a bad idea.

Bad Idea: Any Airplane Can Be Flown Like Any Other

I think we tell ourselves all airplanes fly alike as a way of saying we don't need to work at relearning when we move from one type to the next. It is even institution-



cepts of crew resource management ignore an input from another crewmember that could have prevented the accident in the first place? Sometimes being taught CRM doesn't mean you've fully embraced it.

The former Marine Corps pilot was a decorated combat veteran who had been taught that it is wiser to land an

View of N23AC fuselage.

alized by one of the Flight Safety Foundation's Golden Rules: "Automated Aircraft Can Be Flown Like Any Other Aircraft."

The crash of a Gulfstream GIV (N23AC) on Oct. 30, 1986, was due to the pilot's inability to maintain directional control in a crosswind during takeoff.

The aircraft started to diverge from the centerline less than 1,000 ft. into the takeoff roll. The GIV departed the paved surface, landing gear and other components separated from it, then the airplane slid on its belly, became airborne momentarily, and crashed into a parking lot. Everyone on board was killed.

The NTSB and the world at large placed emphasis on the position of a switch in the cockpit that links the nosewheel steering to the rudder. Older Gulfstreams (the GIII and previous) didn't have a connection between the rudder pedals and the nosewheel steering; the switch was designed to make them comfortable with old techniques in a new airplane.

In the GIV and those models that followed, I've yet to see a credible reason to ever disconnect the pedals from the nosewheel steering. But I don't think this had anything at all to do with the crash.

So, why did the pilot lose control of the aircraft? The answer was buried in the NTSB report: "The PIC tended to unload the nosewheel on the GIV during takeoff to make it easier on the airplane on rough runways." This is a poor technique in a multiengine jet. Such aircraft have a large vertical fin and rudder to compensate for the adverse yaw from an engine failure. With or without an engine failure, that fin acts as a weather vane and tends to turn the aircraft into the wind. The primary responsibility of every pilot is to maintain aircraft control and in a crosswind a tricycle gear airplane — certainly a GIV — needs to have the nosewheel on the runway at least until reaching its minimum control speed on the ground (VMCG).

The winds were 60 deg. off runway heading at 20 kt. gusting to 35 kt. at the time of the accident. The aircraft was controllable on the ground so long as the nosewheel stayed there until rotation speed, as is the standard operating procedure on that airplane. This pilot caused the crash by using procedures from his light aircraft experience, which were unsafe in this larger, multiengine jet.

Every change of aircraft should involve an inventory of procedures and techniques to see what works and what doesn't. Your best source of information may be someone who had made the transition before you and has enough experience to have been "bitten" once or twice. But don't rely on just one source. For example, if your favorite Gulfstream pilots tell you the airplane is landed "wing low" in a crosswind, find another source.

Bad Idea: The Mechanic Already Did the Preflight



Close-up of the outflow valve static port.

I hear this all the time, and sometimes I hear it during recurrent. It is so obviously wrong, I continue to be surprised when it's said. Take, for example, the need to check pitot tubes and static ports.

On April 10, 2015, a Gulfstream GIV (N450KK) departed Simón Bolívar International Airport, Venezuela (SVMI) bound for Fort Lauderdale Executive Airport, Florida (KFXE). Just prior to beginning their descent, the crew noted an over-pressurization warning that indicated a differential pressure in excess of 9.8 psi. At this point the aircraft's cabin pressure relief valve (CPRV) should have opened but did not. The crew heard a loud "bam!" in the cabin and initiated an emergency descent 2

min. and 15 sec. after the initial warning. The pilots leveled off at 20,000 ft. when the over-pressurization message extinguished. Two minutes later it re-illuminated. The crew continued the descent, manually opened the pressurization valve, and continued to KFXE unpressurized.

The reason for the over-pressurization was never determined, but the failure of the CPRV was traced to a static port blocked by dirt from a mud dauber. The loud "bam!" was internal structural damage that did not cause the airplane to depressurize. According to Gulfstream, a blocked CPRV static port would render the CPRV inoperative due to its inability to measure the cabin-to-atmosphere pressure differential. However, the cabin pressure could still be controlled independently by manual operation of the outflow valve or by shutting off bleed air for pressurization. No other mechanical anomalies were found with the pressurization system.

Inspecting the CPRV static port is a part of the GIV Airplane Flight Manual exterior preflight inspection and is easily accomplished without any special stands or tools. A photo of the static port clearly shows it was blocked. It is all too easy to assume everything was OK before, so it is going to be OK again. It is especially tempting to think that when the weather is very cold or very hot. But the price of missing things can be very high.

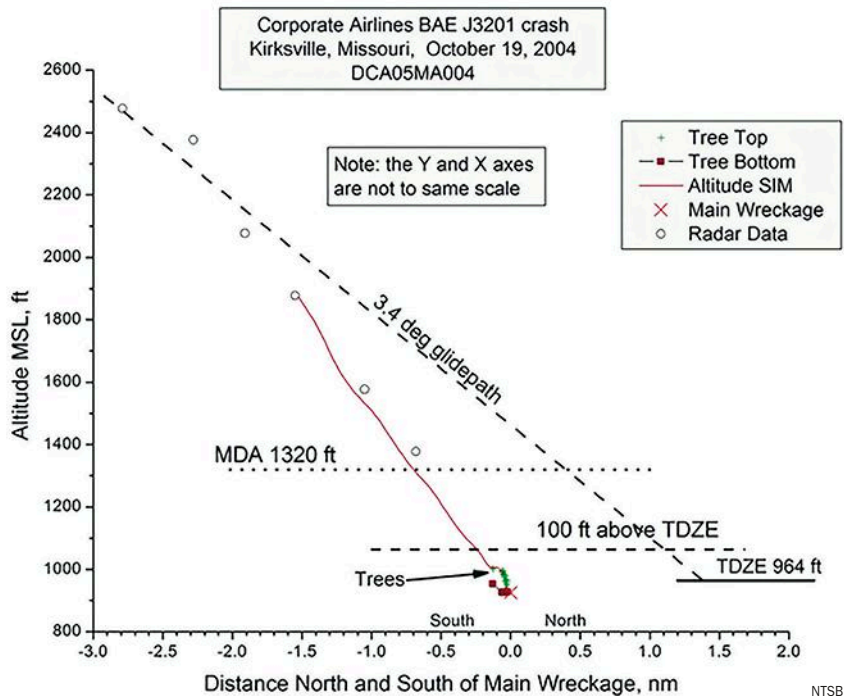
Bad Idea: If the Approach Doesn't Exist, Build One

We quite often see accidents caused by pilots who want only to fly visual approaches, even in questionable weather. But there are also cases in which pilots

PAKISTAN SAFETY INVESTIGATION BOARD



Air Blue Flight 202



Corporate Airlines Flight 5966 descent profile.

minimum descent altitude (MDA) while on approach to St. Louis Lambert International Airport, Missouri (KSTL) and struck the terrain well short of the runway. Both pilots and 13 of 15 passengers were killed.

The aircraft was technology-poor, but the pilots had what they needed to compute a visual descent point and the techniques to do so were well known at the time. The crew's joking banter prior to the instrument approach may appear harmless, but it sets the wrong tone for the serious work ahead of them. Finally, the first officer missed several opportunities to call for a go around when he lost sight of the runway while below the MDA.

One of the ironies of this mishap is that 28 min. before their deaths, both pilots were talking about hating pilots who "take themselves too serious." In the end, they didn't take what they were doing seriously enough:

1909:30 (HOT-1): "Gotta have fun."

1909:31 (HOT-2): "That's truth man. Gotta have the fun."

1909:35 (HOT-1): "Too many of these # take themselves way too serious in this job. I hate it, I've flown with them and it sucks. A month of # agony."

1909:47 (HOT-1): "All you wanna do is strangle the # when you get on the ground."

1909:50 (HOT-2): "Oh # . . . [sound of laughter]."

1909:52 (HOT-1): "Oh *, yeah, oh well, he was one but I didn't, I didn't have to fly with him that much 'cause. . ."

1909:56 (HOT-2): "I know."

1909:57 (HOT-1): "It was kinda a fluke. But, uh, some of the guys that aren't here anymore you wanted to just # kick 'em in the #. Lighten the # up #."

The pilots failed to make several mandatory callouts, any one of which could have changed the outcome.

Bad Idea: Getting More Performance From the Airplane Than the Guys Who Designed It

When I was in the ratings chase, flying my trusty T-37, I often stretched the range string to its maximum. A training sortie was usually 1.3 hr., but we could get 2.0 out of the airplane. I've done 16-hr. flights in the Boeing 707 and 20 hr. in the Boeing 747. But those included

cannot seem to fly without some kind of electronic course guidance, even if it means building that guidance despite regulatory restrictions. Can you build your own approach? Yes. Should you? There are so many ways to get it wrong that the answer has to be "No."

The captain of Air Blue Flight 202, an Airbus A321, was worried about having to circle at Chaklala International Airport, Islamabad, Pakistan (OPRN) on July 28, 2010. The weather was just good enough for the left pattern. For some unknown reason, he preferred the right pattern and had the first officer build that into the FMS. Tower denied their request for a right pattern several times, due to low clouds on that side of the airport. The captain commanded the right turn for the pattern by selecting heading mode. He then heard a competing airline had just landed, flying the left pattern. The accident report said that "put the captain under further pressure to ensure a landing at Islamabad under any circumstances."

The report speculates that the captain decided to fly a right pattern at this point by saying he was "going for NAV" but neglected to select the mode. The aircraft remained in heading mode even as the crew noted passage of the waypoints they had built. The crew looked in vain for the airport (perhaps looking to the right when it was to the left) until about several miles north of the airport, at which time NAV was selected. The radar controller instructed them to turn left. The captain said he was turning left, but he was moving the heading bug while the autopilot was still in NAV

mode. They hit the terrain a few seconds later and all 152 persons on board were killed.

There was much more going on in the cockpit, not the least of which was a breakdown in CRM. I think the Pakistani report suffers in translation, so the facts are not explicitly laid out. The ad hoc approach they had built in the FMS didn't cause the crash, but selecting the approach after the pilots became lost delayed their recognition of a need to go missed approach before they impacted the terrain.

There are times when flying what the nav world calls a PBD (place/bearing/distance) waypoint helps situational awareness and should be encouraged. But you should never fly such a waypoint as a means of getting down to instrument minimums or navigating through terrain. The practice is prohibited by several FAA Advisory Circulars and orders. Besides, it is dangerous.

Bad Idea: Callouts Are for Newbies

I have been in social settings where the topic du jour was how some pilots took themselves too seriously (perhaps it was an intended jab at me) or, on the other side of the debate, there was far too much chatter in the cockpit and wouldn't it be best if nothing was said at all? I like a quiet cockpit, but I also like standard callouts.

The crew of Corporate Airlines Flight 5966, a British Aerospace 3201 Jetstream 32EP, descended below their

multiple air refuelings. I've done a 10.0 in the G450 and 14.5 in the GV. But in all of those cases, you could rebuild the flight using the AFM performance charts. If you are doing better than your charts, you are probably doing something wrong.

On April 4, 1979, Trans World Airlines (TWA) Flight 841 was flying from New York-JFK International Airport (KJFK) to Minneapolis-St. Paul International Airport (KMSP) when a leading-edge slat asymmetry caused the airplane to roll uncommanded while at cruise altitude. The NTSB determined the asymmetry was caused by the crew's manipulation of the flap/slat controls, but there was some dispute as to why. The Safety Board was very careful in its choice of words, but the talk among Boeing 727 and TWA pilots at the time was this:

► The trailing edge flaps on the Boeing 727 extend aft a great deal before they extend down. If it were not for the automatic deployment of the leading edge slats, the first notch of flaps would turn

the wing into one that produces more lift (greater span with very little change in camber).

► There was a belief among some Boeing 727 pilots that you could increase the airplane's speed by pulling the circuit breakers on the leading edge slats and extending the trailing edge flaps to their first notch.

► The mishap pilots did just this while the flight engineer was aft using the lavatory. When the engineer returned to the cockpit, he noticed the popped circuit breakers and reset them, causing the leading edge slats to extend.

► This caused a buzzing sensation, prompting the captain to retract the flaps. When he did this, the No. 7 leading edge slat failed to retract, causing the subsequent roll.

A manufacturer has hundreds and even thousands of hours in the certification process to explore an airplane's envelope. It is in the company's financial interest to get the most performance out of the airplane as is safely possible. This is accomplished with highly experienced pilots backed up

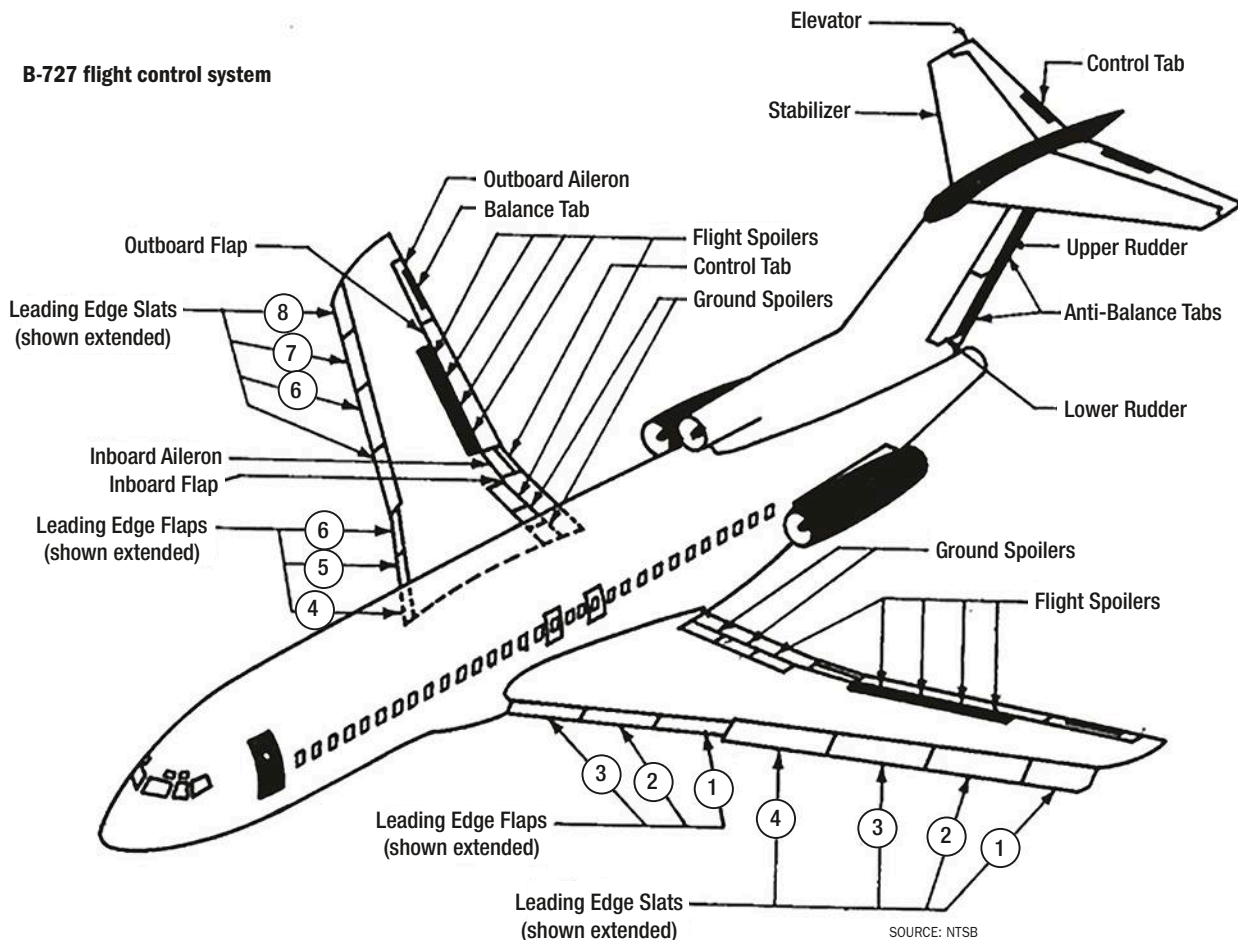
by teams of engineers. If you think you've come up with a better way to fly the airplane, you are probably wrong.

Are 'Bad Ideas' in the Eye of the Beholder?

I once heard of a pilot who swore you could increase an airplane's en route speed by over-pressurizing it in a tailwind, thereby increasing its cross-section and thus the "push" it got from the wind, or under-pressurizing it in a headwind to decrease the aircraft's cross-section and thus its resistance to the wind. I am positive that person finished his or her flying career believing that.

I think one of the finest attributes in a professional pilot is humility: the knowledge that you cannot know it all, can always learn, and have to be aware of the fact you may someday find yourself in uncharted territory. The best way to avoid such unwelcome pioneering is to stick to known procedures, which produce known outcomes. **BCA**

B-727 flight control system



DISCOVER THE ULTIMATE DIFFERENCE™



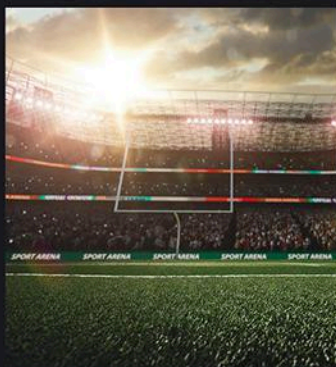
- DORNIER 328 & EMBRAER 135LR JETS
- STATE-OF-THE-ART AIRCRAFT

- 30 PASSENGER CONFIGURATIONS
- ALL LEATHER INTERIORS

OUR 30-SEAT JETS ARE PERFECT FOR:



Corporate Travel/
Shuttle



Sports Team/
Fan Travel



Project Travel/
Shuttle



Casino/Resort
Trips

CALL TODAY!

EDDIE MONEYPENNY · 330.620.9400

OR

JEFF MONEYPENNY · 330.620.7400

ULTIMATE
JETCHARTERS

AircraftBluebook

PRINT & DIGITAL SUBSCRIPTIONS | APPRAISAL SERVICES | DATA LICENSING

CONVERSIONS &
MODIFICATIONS

SERIALIZATION
BY MODEL YEAR

MAINTENANCE PROGRAMS

NEXT GEN AVIONICS

TRUST

Know the Value

For over 65 years, Aircraft Bluebook has been the industry's go-to source for **reliable and accurate** aircraft valuations, providing in-depth data and information to the global business and general aviation community.



AVIATION WEEK
NETWORK

Visit aircraftbluebook.com for more info.

What's It Doing Now?

Prioritizing instrument **standardization and simplification**

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



Decades ago, we were flying an FMS demonstration in a Beech King Air with conventional analog flight instruments, a basic weather radar and an analog autopilot. The purpose of the demo was to show off the advanced capabilities of the FMS, including its ability to automatically transition from the en route to the approach mode.

The avionics firm that owned the aircraft suggested that we challenge the system by selecting a non-precision approach with a DME arc from the initial approach fix to a fix on the final approach course inbound to the airport. The approach also had numerous vertical step-down fixes that assured the

Less is more. Clear, consistent conventional colors and symbols are essential.

aircraft would have safe altitude margins from close-in high terrain. The FMS provided roll steering commands to the autopilot for lateral guidance, but we had to control the vertical flight path manually as we passed over each step-down fix.

As the aircraft only had a basic weather radar, there was no moving map to provide graphic indications of FMS operation. And this was long before tablet computers could be linked to avionics systems by Wi-Fi and Bluetooth.

The tiny screen of the FMS CDU, mounted low in the center console,

was only capable of displaying a single, monochrome line of near cryptic alphanumeric abbreviations. The aircraft also had a few additional annunciator lights above the flight director, but they were there to confirm that the navigation system was working properly rather than to enhance situational awareness.

Not long after some arcane message popped up on the CDU, the flight director commanded a turn to intercept the DME arc.

We then asked, "What's it doing now?"

"Trust me. It's working properly,"

HONOWELL

STANDARDIZING PFD COLOR CONVENTIONS

MAGENTA	FMS, GPS or computer managed guidance, targets, speeds, alter-trend vectors
CYAN	Pilot selected targets, speeds, altitudes
GREEN	Active modes
WHITE	Standby or selected modes; system status; information
YELLOW	Cross-side source: AHRS, navigation, FD, AP, DADC, AT
AMBER	Caution
RED	Warning

Figure 1

multifunction display can provide both functions.

Color has long been used on analog instruments to make them easier to interpret, to enhance situational awareness. But on analog instruments, those colors are fixed. They cannot change according to mode, function or nav source. On EFIS displays, by contrast, colors can be varied to alert pilots to just such changes.

The flexibility with which EFIS displays could be configured led airframe and avionics makers to be highly creative in crafting display symbols and color coding. Each manufacturer was confident that its approach was

responded the avionics firm's demonstration pilot.

But other than the rapid-fire sequence of cryptic characters that appeared on the CDU screen and the occasional mode annunciator lighting up, it was nearly impossible for us to monitor and verify FMS performance, even as we had the autopilot coupled, smooth air and daylight VFR conditions.

The FMS sucked so much focus out of us that we missed descending to the next published altitudes at a few step-down fixes. We also had to be prompted to complete the landing checklist.

"It'll be much easier after you've flown with it a while," assured the demo pilot.

We were not convinced. To keep us in the loop effectively, it would have been better to fly the entire procedure by tuning radios, twisting knobs, pushing buttons, flipping switches and monitoring instruments. It would have been just pilot making inputs to the aircraft, instead pilot making inputs to a box, and trusting blindly that it would make the appropriate inputs to the aircraft.

Since the introduction of FMSes in the early 1980s, avionics makers have made great strides in improving situational awareness by providing clearer messages on CDUs and by tying the boxes to MFD moving maps.

However, several fatal accidents involving breakdowns in pilots' situational awareness with respect to cockpit automation provide clear and convincing

evidence that considerably more needs to be done to standardize and simplify interfaces between humans in front of the screens and the computers behind the screens.

The American Airlines Flight 965 controlled flight into terrain crash in Colombia in 1995 and the Cessna Citation CJ4 crash into Lake Erie in late December 2016 are two fatal accidents that involved critical failures in human/machine interfaces.

Standardizing Displays

In the early 1980s, aircraft manufacturers started to make the transition from conventional analog instruments to electronic flight information systems (EFIS) using CRTs. Most of those embryonic EFIS tubes just mimicked the analog, electromechanical gauges they replaced.

Avionics manufacturers' first priority was to replace high-maintenance, electromechanical flight director/attitude director indicators (ADIs) and horizontal situation indicators (HSIs) with EFIS tubes with the goal of increasing dispatch reliability and decreasing maintenance costs.

Electronic displays also can change personality at the touch of a button or twist of a switch. If one display fails, an adjacent display can host combined functions, the so-called "reversion" mode. The capability adds essential redundancy. Thus, if a primary flight display fails, an adjacent navigation or

the best solution for the human/machine interface on the flight deck.

Quite quickly, the cockpits in various aircraft evolved vastly different personalities. Early on, however, the FAA and the NTSB recognized that such individualized cockpit designs posed the possibility of pilot confusion when flight crews transitioned from one aircraft model to another. The agencies began actively promoting standardization of color sets, symbols and instrument layouts.

As things evolved, those efforts were in vain. Avionics and airframe manufacturers pushed back hard, arguing that rigid standardization would stifle innovation. A stalemate ensued. The result was FAA Advisory Circular AC 25-11, which provides general guidance, but not mandates, for "design, installation, integration and approval of electronic flight displays" and other components in transport category aircraft. Its guidance is so general that manufacturers are afforded considerable leeway in choices of colors, symbols and EFIS layouts.

Aboard the Gulfstream GIV, for instance, engineers specified that the PFD airspeed tape on the Honeywell SPZ-8000 system should move from the bottom up, rather than top down. Larger airspeed numbers rolled up from the bottom of the scale.

Choice of colors was another point of contention. Gulfstream and Honeywell, for example, chose to depict long-range navigation guidance cues in cyan while

STANDARDIZING PFD FLIGHT MODE ANNUNCIATIONS

AUTOTHROTTLE MODE	LATERAL NAV MODE	VERTICAL NAV MODE	APPROACH STATUS	AUTOMATION STATUS
FMS SPEED	HDG LOC	ALT HOLD G/S	CAT I DH 200	AP1 FD1 AT1

Figure 2

other manufacturers opted for magenta. Green generally was the color that depicted short-range navigation cues from ILS, VOR and ADF. Meanwhile, Boeing chose magenta for both long-range and short-range navigation cues.

Most manufacturers chose green to indicate active modes, but some opted for white to show standby or inactive modes, while others picked cyan or blue.

Airframers also chose a wide variety of layouts for PFD flight mode annunciators (FMAs). Airbus, for example, uses five columns to indicate autothrottle, vertical and lateral modes, plus approach capability and flight director/autopilot/autothrottle status. Green depicts active modes and blue shows standby or selected modes. White is always used to indicate approach and automation status.

Meanwhile, rival Boeing opted for three FMA columns — autothrottle status, lateral and vertical modes. Active modes are shown in green and selected or standby modes appear as white messages.

In the past decade there has been a trend toward more standardized colors and symbols in newer models. Certain color conventions are emerging. And flight crews are going to discover that it's easier to adapt to the new flight decks.

As shown in **Figure 1**, FMS and computer-generated navigation guidance cues, targets, speed and trend vectors typically are shown in magenta on many newer PFDs. Cyan depicts

pilot-selected speeds, altitudes, headings and other targets. Green indicates active modes and short-range navigation cues, such as lateral and vertical course guidance. White shows standby and selected modes, plus useful information. It's also used for pointers and scales.

Yellow indicates a cross-side source, such as AHRS, DADC, FMS or another system, is being used to drive on-side indications. Amber is reserved for cautions and red signifies warnings.

Standardization of FMAs is equally important to situational awareness on the flight deck. As shown in **Figure 2**,

plus approach and automation status. In the example, the FMS is controlling the autothrottle, the heading lateral mode is active with ILS localizer selected and armed, and altitude hold is active in the vertical navigation mode with glide-slope selected and armed. Some manufacturers will box or outline a mode annunciation when it changes from standby to active for 5 to 10 sec. to attract the pilot's attention to the switch. On newer systems, it's possible to use reverse video for a short period of time to flag the switch more effectively.

As shown in the approach status column, the aircraft is configured for a Category I approach and the pilot has manually dialed in a 200-ft. decision height. That's why it's shown in cyan. The automation status column indicates that autopilot channel 1, flight director channel 1 and autothrottle channel 1 are selected and available.

There's much less deviation in color conventions used for engine instrument and crew alerting systems (EICAS) and electronic centralized aircraft monitoring (ECAM) systems. Warning messages take priority and are at the top of the screen, followed by cautions, information and status messages. In the example shown in **Figure 3**, the EICAS shows a red fire warning message for the left engine. It's also depicted in reverse video, indicating that the pilot must acknowledge it before it will appear in red text on the black background. Amber caution messages for low hydraulic, oil and fuel pressures are side effects of the left engine fire. Status messages are shown in white, such as for a VHF data-link communications radio, satcom system and radio altimeter that are inoperative. The cyan or blue messages at the bottom are advisories that indicate a fire extinguisher has been armed and that engine and wing anti-ice systems have been activated.

STANDARDIZING EICAS / ECAM COLORS

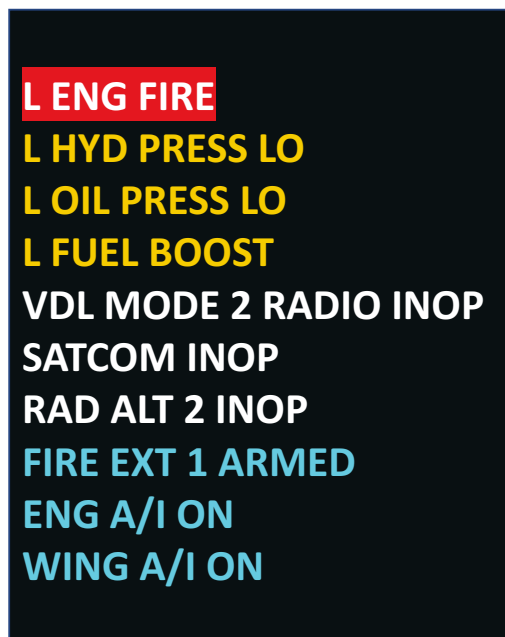


Figure 3

Drowning in Data? Time to Draw Pilots a Picture

FMS programming has become easier in recent years, but there's still plenty of opportunities for improvement. Start with the initialization process. Current-generation FMS boxes typically prompt the crew to confirm GPS position or enter another position, such as lat/long. This poses a potential risk factor as the crew might accept an erroneous GPS position or make a "fat finger" entry error into the box.

So, rather than prompt the crew to make or confirm an alphanumeric value, what if the FMS box simply showed aircraft position on an airport diagram displayed on the MFD? As shown in **Figure 4**, the indicated aircraft position

procedures best suited to the mission.

Prior to belting into the cockpit, pilots potentially face the daunting task of deciphering and interpreting dozens of NOTAMs. One airline captain, flying for a major U.S. air carrier, said he would never leave the ground if he had to read and interpret up to 75 pages of NOTAMs and other advisories for some of the airports he uses. He's lucky if he has time to weed through half of the paperwork, hopefully not overlooking notices that could pose critical risks to the mission.

NTSB Chairman Robert Sumwalt, himself a former airline captain, says the current FAA NOTAMs are "a bunch of garbage that no one pays attention to" and that they're written in a form only computer programmers can inter-

computing power, ever-sharper display screens and strong growth in digital databases are making possible synthetic vision PFDs with 3-D airport diagrams, interactive taxi diagrams and graphic portrayal of landing touchdown points and stopping distances. In some aircraft, such as the Airbus A350, pilots can even graphically select the taxiway that they would like to use in exiting the runway after landing, using an interactive airport diagram. The function is called "brake to vacate" and it works dynamically as a function of touchdown point, touchdown speed and distance remaining to the exit point.

ADS-B In is another graphic safety enhancement that will enable pilots to spot other aircraft and ground service equipment in motion on airport diagrams shown on cockpit displays. ADS-B Out mainly benefits ATC's safe and efficient flow of increasingly dense air traffic. ADS-B In is an equally important payoff for operators.

General aviation aircraft manufacturers regularly convene customer advisory boards, providing operators with what improvements they need made to their aircraft and what features they would like built into new models. A healthy exchange of information provides essential feedback.

An even broader discussion of these issues through BCA could be beneficial. So, we're asking you to tell us what cockpit standardization and simplification improvements you think are most needed to enhance situational awareness, prevent "fat finger" entry errors and promote safety of flight. You also can give us your opinions about distractions

built into some avionics systems that, if eliminated, would enable pilots to focus more clearly on critical tasks. Three- and four-layer-deep menus, for instance, invite pilots to spend excessive time head-down, pressing buttons instead of being head-up watching for hazards and monitoring flight instruments. Selecting choices of inflight entertainment may not be appropriate avionics functions during critical phases of flight, in our opinion.

We await your comments and suggestions. We anticipate a lively discussion and we'll keep our readers posted on the results. **BCA**

GRAPHIC FMS INITIALIZATION

Aircraft parked at Signature Aviation KLAX

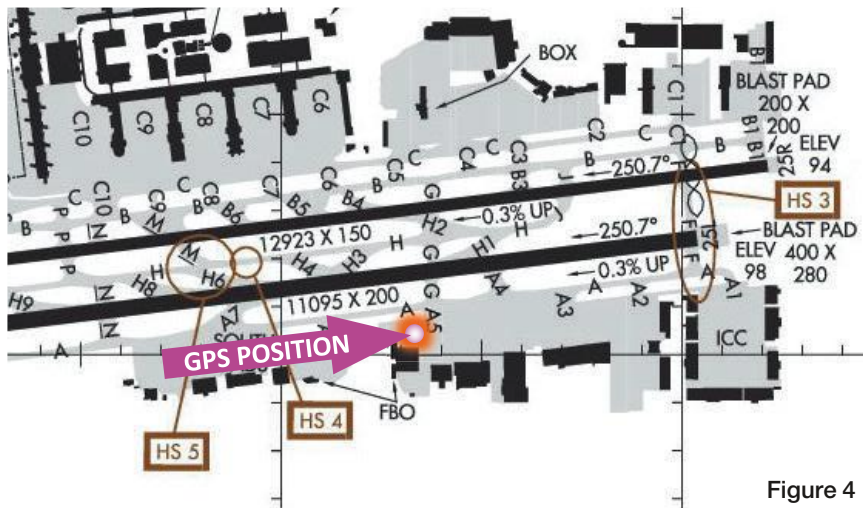


Figure 4

is on Signature Flight Support's ramp on the south side of Los Angeles International Airport. If the pilot agrees with what's on the screen, then a simple button push would be all that is necessary to complete position initialization.

Using graphics has the potential to simplify and clarify the programming of other elements of a flight plan into the FMS box. What if departure and arrival procedures could be viewed on screen in relation to the flight plan route before they're selected and activated? Subject to air traffic control constraints, that might help the crew to visualize and request the

pret. The FAA already provides TFRs, airspace boundaries and areas of significant weather in graphic form. Why not digitize NOTAMs so that they can be graphically presented on airport diagrams and other aviation charts?

Your Feedback Is Needed

We've briefly summarized some of the cockpit standardization and simplification initiatives that have been implemented and noted some other opportunities to improve situational awareness by replacing text with graphics.

Quantum increases in avionics

AirCharter

GUIDE



Know Your Options

So many destinations.

So many aircraft.

One source: aircharterguide.com.

Cabin Ozone

Are you exposing **your passengers and yourself to danger?**

BY **PATRICK VEILLETTE** jumpraway@aol.com

As pilots, among our foremost duties is the protection of the safety and health of our passengers as well as ourselves. And yet, there is a potentially serious “poison” at high altitude that can cause long-term health effects on all aboard and about which you’ve likely never been trained. It’s ozone.

The advantages of high-altitude flight are clearly evident. Generally, there is less weather or the convective turbulence found at lower altitudes. Moreover, our turbine engines are optimized for high altitudes, so fuel efficiency is better there and the thinner air means less drag so we can fly farther and faster. As a result, many business jet pilots and passengers will spend thousands of hours breathing the air from our aircraft ventilation systems at 40,000+ ft.

One downside of high-altitude cruise, especially above the tropopause, is the presence of significant concentrations of ozone in that rarefied atmosphere. Stratospheric ozone is considered beneficial in protecting the earth from potentially harmful ultraviolet radiation.

However, exposure to the colorless gas, which is formed from oxygen by electrical discharges or ultraviolet light, is known to cause adverse health effects. Persons exposed to ozone can experience headaches; fatigue; shortness of breath; chest pains; nausea; sinus irritation; coughing; irritation of the eyes, nose or throat; asthma-exacerbation; pulmonary distress; and premature mortality in susceptible passengers. Some symptoms attributed to jet lag may actually be caused by ozone.

Ozone can damage through emphysema, an irreversible condition involving

loss of elasticity of the structure of the lungs. Chronic exposure has been tied to reduced lung function in young adults and adult-onset asthma in males, as well as a significant increase in the risk of death from respiratory causes.

The low concentration of ozone below the tropopause is not likely to create health problems for aircraft occupants. Thus, cabin ozone levels for relatively short flights or in aircraft that don’t climb above the tropopause are unlikely to approach threatening levels. However, flight above the tropopause puts the aircraft into potentially threatening levels of the gas.

The tropopause forms a definitive demarcation above which the concentration of ozone increases rapidly to potentially harmful amounts. The tropopause height varies with geography and seasons, as well as locally due to significant storms that cause mixing



ANSONMIAO/ISTOCKPHOTO

of the air between the stratosphere and troposphere. Common literature on the tropopause says the average height is 49,000-59,000 ft. (15-18 km) in the tropics to 22,000 ft. (6.8 km) near the poles. Advanced research has found the change in tropopause height with latitude is neither linear nor constant but instead exhibits considerable jumps across the jet stream. In spring, the tropopause height is at a seasonal minimum and in the fall it is at a seasonal maximum in the northern hemisphere.

One of the most extensive collections of inflight data on tropopause height and upper atmospheric ozone levels was collected by the MOZAIC (Measurement of Ozone and water vapor by Airbus In-service airCraft) project. The aircraft were fitted with sensors on their shells. Researchers from the University of California-Berkeley's Department of Civil and Environmental

Engineering looked at MOZAIC data from Airbus A340 flights between Munich, Germany, and Los Angeles (175 flights), Chicago (372 flights) and New York (318 flights) that occurred from 2000 to 2005. They used the inflight data to assess ozone levels encountered, to evaluate the influence of season, latitude and altitude on the levels, and to consider implications for exposures within aircraft cabins.

They discovered that the ozone levels varied considerably across the 865 flights, illustrating in part that they vary markedly through the year. The highest amount of ozone recorded in 1-hr. time periods throughout the flights ranged from 90 to 900 parts per billion (0.09 ppm to 0.9 ppm), while the flight-average atmospheric ozone level was 50 to 500 ppb (0.05 to 0.5 ppm). That is a tenfold variation. We'll briefly touch on why such variation complicates ozone-avoidance strategies.

UC professors Seema Bhangar and William Nazaroff found the average and 1-hr. peak levels were, respectively, 180 ppb and 360 ppb higher in April than during October-November. Why? Flights at normal cruising altitudes of large transports have a higher chance of crossing into the lower stratosphere and encountering elevated ozone in the spring than during the fall.

Since the tropopause is lower over the polar regions, one might think that the flights from Munich to Los Angeles, which traverse a more northerly route, would encounter higher average ozone concentrations than those to Chicago and New York. Surprisingly, that wasn't the case. Bhangar and Nazaroff did not find a systematic increase with latitude in the ozone concentrations encountered by transatlantic flights between 30 deg. north and 60 deg. north.

Quite the contrary, the data showed that flights to Chicago and New York flying on northern midlatitude routes routinely experienced higher average ozone concentrations because of a high ozone region centered in the western North Atlantic. By traversing higher latitudes, flights between Munich and Los Angeles avoid much of the "high ozone" of that region. Another important finding from this inflight data was that the highest atmospheric ozone concentration levels occurred during occasional localized reductions in tropopause height in January-March in that western North Atlantic region in complex upper atmospheric

mixing processes associated with deep storms.

Flight route planning is one method that aircraft operators have used to comply with ozone FARs. Data to aid with flight planning are based on statistical summaries of atmospheric ozone as a function of altitude, latitude and month. However, Bhangar's inflight data suggest that within the transatlantic flight corridor, latitude is not associated with a smooth linear increase in the tropopause's height. So, flight route planning based on expected latitude trends may not be effective. The statistical tables are based on averages that do not completely capture the considerable variation of atmospheric ozone concentrations.

How much ozone might be in the cabin air of your aircraft? It depends. The amount of ozone inside depends not only on the atmosphere outside, but also on the aircraft's ventilation system, materials making up the cabin surfaces, density of occupants and ratio of surface area to volume. (The latter three topics get into areas of organochemistry that delve into discussions not likely to be of interest to 99.9% of pilots unless they have an advanced degree in the science.) The rest of this article will focus on aspects that pilots can control.

Researchers from the Harvard School of Public Health monitored ozone concentrations in passenger cabins of 106 commercial flights on domestic, Pacific and Southeast Asian routes. One-fifth of the measurements exceeded 100 ppb. According to both the FARs and JARs, when above 27,000 ft. for each flight segment that exceeds 4 hr., ozone concentrations must not exceed an average 100 ppb. So, the data suggest that those aircraft either lacked converters or their converters were not functioning effectively. And slightly more than one in 10 of the flights exceeded 120 ppb, the U.S. Environmental Protection Agency's short-term national Ambient Air Quality Standard for ozone. Seasonal comparison showed that cabin ozone levels were higher during the winter and spring than for the summer and fall, which would be consistent with the seasonal variation in the height of the tropopause. Cabin ozone concentrations on the northern Pacific routes were higher than concentrations for other Pacific flights.

A team from UC-Berkeley, again involving professors Bhangar and

Nazaroff and others, also monitored cabin ozone levels on 76 commercial passenger flights on domestic U.S., transatlantic and transpacific routes during 2006 and 2007. On four (out of 68) domestic flights, ozone levels exceeded federal limits of 100 ppb even though 22 of 68 aircraft sampled were equipped with ozone catalysts. The “mean peak-hour” ozone level was one-tenth (only 4.7 ppb by volume) compared with the 46 airplanes not equipped with catalysts (47 ppbv). All eight aircraft sampled during transoceanic flight segments were equipped with ozone catalysts and showed ozone levels well within FAA limits. The researchers also found that the flights

with the highest levels of ozone coincided with winter-spring storms that are linked to complex upper atmosphere mixing processes between the lower stratosphere and the upper troposphere.

The UC-Berkeley team estimated that more than 95% of the flights between February and June analyzed in the study would have exceeded the 100 ppb (0.1 ppm) mark for flight-average ozone levels inside the cabin if ozone converters were absent or ineffective. The Berkeley team expressed concern that even on domestic U.S. routes — which are frequently traversed by airliners unequipped with ozone converters — elevated ozone levels of hundreds of

Regulatory Limits and Recommendations

JAR Part 25.831/841, Amendment 16 and FAR Part 25.831/841, Amendment 105 provide regulatory limits on the amount of ozone allowed in cabin air. (FAR Part 25.832 was added in January 1980 following complaints from crewmembers and passengers about various adverse health effects associated with ozone in the airplane cabins. FAA Advisory Circular AC-120-38 provides further clarification on the certification.)

Damage from ozone is far more related to the concentration level than the period of exposure. Thus, at any given instant while in flight above 32,000 ft., the in-cabin ozone must be less than 0.25 parts per million by volume (ppmv). Above 27,000 ft. for each flight segment that exceeds 4 hr., the time-weighted average amount of ozone must be less than 0.1 ppmv. Healthy persons can apparently endure indefinite exposure to levels below the maximum specified by the FAA as “harmless.”

A task force of subject matter experts was appointed by the non-partisan National Research Council due to concerns about the adverse health effects of exposure of aircraft cabin occupants to elevated levels of ozone. In 2002, the Committee on Air Quality in Passenger Cabins of Commercial Aircraft issued “The Airliner Cabin Environment and the Health of Passengers and Crew” (National Research Council, National Academy Press, Washington D.C.). The study noted that passengers and flight attendants on frequently traveled routes through atmospheric zones with elevated concentrations of ozone are at an increased risk for ozone-related health effects. (Curiously the study did not mention concern for pilots. One can infer the study’s authors also would have included pilots.)

The NRC’s report recommended the FAA take effective measures to ensure that the current FAR addressing ozone exposure is met on *all* flights, regardless of altitude. These measures should include a requirement that either ozone converters be installed, used and maintained on all aircraft flying at or above those altitudes, or strict operating limits be set with regard to altitudes and routes for aircraft without converters to ensure that the ozone concentrations are not exceeded in reasonable worst-case scenarios. To ensure compliance with ozone requirements, it recommended the FAA conduct monitoring to verify that the ozone controls are operating properly. **BCA**



ppb are routinely encountered in the winter and spring months.

According to the National Research Council (NRC) committee on air cabin quality’s special study, “The Airliner Cabin Environment and the Health of Passengers and Crew,” “It appears that an ozone converter on large transport category airplanes may be the most robust methodology to ensure consistent, successful compliance with regulations governing airplane ozone control.” The NRC study also highlighted that flight attendants are more likely to be adversely affected by cabin ozone as the level of discomfort is proportional to the level of physical activity.

Ozone is chemically unstable and its decomposition is accelerated by heat and contact with metallic surfaces. But even though bleed air extracted from the engine’s compressor is plenty hot and the piping is made from metal, those factors may not be sufficient to mitigate the ozone threat when outside concentrations are elevated. Thus, to meet the limitations on cabin air ozone levels, high-flying transport aircraft should be equipped with fully functional catalytic devices and carbon filters that remove gas from the cabin.

Catalytic ozone converters typically consist of a metal housing that encloses a precious-metal catalyst. The cores are coated with chemical compounds



TOLOKONOV/ISTOCKPHOTO

that, when combined with the elevated temperatures of the bleed airflow, become the catalyst in converting ozone to standard oxygen. The converters have an expected ozone destruction efficiency of 90%-98% when new. However, that efficiency tends to degrade with use.

According to RSA Engineered Products LLC, an engineering company that has designed a dual core ozone converter, other converters do not always perform well due to surface “poisoning” by various contaminants or imperfect refurbishing of catalysts during scheduled replacement. The accumulation of particles on their absorbent surface further decreases the efficiency of carbon absorption filters. This leads to costly filter maintenance or replacement, and until then, the converter’s effectiveness is likely to allow excessive concentrations of ozone into the cabin.

Ozone converters are subject to replacement or maintenance once the efficacy drops below approximately 60%. At that level, the UC-Berkley study predicted that 97% of flights from February through June would exceed the peak 1-hr. ozone level of 100 ppb. These observations highlight the importance of ozone converters functioning well.

How can a pilot detect the presence of ozone? Unfortunately, the human nose is not well suited for the job. Even

Citation X’s Ozone Converters

It isn’t easy for pilots to determine if their aircraft is equipped with an ozone converter. I’ve searched through the thick aircraft flight manuals of the many jets I’ve flown in my career but have seldom been able to find even the mention of “ozone” in the systems descriptions. A query to many friends “flying the line” whether their aircraft were equipped with ozone converters usually brought the reply: “What is an ozone converter?”

A search of part supply numbers from vendors that produce ozone converters showed products for Dassault and Gulfstream aircraft. Pilots seeking comparable information for their specific aircraft might be more successful searching through the maintenance manual.

The following is a brief description I found on line of the Cessna Citation X’s system: “The Citation X is equipped with two ozone converters, one for the cockpit and the other for the cabin. The ozone converters are one-piece assemblies consisting of a ceramic honeycomb core covered by a metal catalyst. Access to the ozone converters is through the tail-cone maintenance access door.” **BCA**

Source: Citation X Temperature Control System

when ozone is detected by smell — it can be pungent — this sense diminishes after a few minutes, giving the illusion that the gas’s level has fallen even though it has not.

According to the Australian Civil Aviation Safety Authority’s study, “Contamination of Aircraft Cabin Air by Bleed Air: A Review of the Evidence,” there is clear evidence of increased levels of a range of potentially hazardous contaminants during routine operating conditions, including ozone when flying at high altitude.

The NRC report expressed concern that “In addition, future airplanes will be able to cruise at higher altitudes in the stratosphere where the concentration of external ozone is much higher than in the troposphere.” That report focused on large transport aircraft,

whereas many business jets had been capable of flying at high altitudes well above the tropopause long before its publication. The safety implication is obvious as business aircraft commonly fly much higher than large commercial transports and thus through atmospheric regions laden with high concentrations of ozone.

High-altitude flight involves numerous unseen hazards, including ozone concentrations. Ignorance of its threat highlights one of the deficiencies in pilot training for high-altitude flight. Unfortunately, the studies on this topic have concentrated on the air quality within airline cabins. The protection of pilots, flight attendants and passengers, particularly in high-altitude business aircraft, deserves equal attention. **BCA**

Aircraft Cabin Ozone Studies

► Seema Bhangar and William W. Nazaroff. “Atmospheric Ozone Levels Encountered by Commercial Aircraft on Transatlantic Routes.” *Environmental Research Letters*, Vol. 8 (2013), No. 1.

► John D. Spengler, David S. Ludwig and R.A. Weker. “Ozone Exposures During Transcontinental and Transpacific Flights.” *Indoor Air*, Vol. 14, August 2004, pp. 67-73.

► Seema Bhangar, Shannon C. Cowlin, Brett C. Singer, Richard G. Sextro and William W. Nazaroff. Civil & Environmental Engineering Department, University of California, Berkeley, California. “Ozone Levels in Passenger Cabins of Commercial Aircraft on North American and Transoceanic Routes.” *Environmental Science & Technology*, 2008, 42 (11), pp. 3938–3943. **BCA**

Finding a Balance Between Work and Life

Being on call 24/7 is driving burned-out **business aviation pilots to the airlines, and flight departments are reacting.**



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

Twenty-five years ago, the phrase “pilot shortage” was an oxymoron as the supply of commercially licensed pilots far outnumbered the demand for crewmembers at the airlines and in business aviation flight departments.

What jobs were available usually went to military-trained aviators with heavy jet experience, and over time, many civilian-trained pilots abandoned their quests for professional flying careers for other pursuits. At my flight school, a respected academy oriented toward producing pilots for the airlines and

business aviation, we used to joke that to be competitive for a commercial flying job, you had to hold a Ph.D. in aeronautical engineering, have ATP and flight engineer certificates (this was the era when the third person on the flight deck “flew sideways”), 5,000 hr. total time — 3,000 of them in “heavies” — and a minimum of three lunar landings. So, not surprisingly, after decades of job scarcity and a commensurate decline in attracting new talent to aviation, the pool of available commercial pilots has pretty much dried up just as a generation of four-strippers is retiring.

I remember a conversation with the founder of my flight academy some time ago in which he complained about the difficulty in attracting young people to piloting careers due to the expense of the training and then the long, underpaid apprenticeship in flight instructing while building time to earn the coveted ATP. “They see the incredible salaries they can nail down in tech jobs and at Wall Street right out of college,” he said, “and they ask, ‘Why would I want to spend all that money and then starve for years without any guarantee of being hired by an airline?’”

and Personal Life in Business Aviation

Losing Balance

As a result, business aviation faces a potential crisis in pilot employment, as well. It seems pilots are leaving good jobs in flight departments and flocking to the airlines. And the impetus isn't necessarily about pay but rather the imbalance between work, or the ad hoc nature of business aviation, and personal lifestyle, or the inability to schedule time off for family responsibilities when one is on-call 24/7/365. Furthermore, the problem is being aggravated by the fact that young pilots and graduates of the aeronautical universities are not seeking jobs in business aviation.

The lifestyle issue is especially critical in smaller, one-aircraft flight departments that are characteristically understaffed, especially those that employ only two pilots to not only fly the aircraft but handle all the other responsibilities inherent in a complex flight operation. As Mr. Rogers would have put it, "Can you say 'burnout'?"

While large multi-aircraft flight departments operated by Fortune 100 corporations may have the resources to employ up to four pilots per airplane, the one-aircraft, two-pilot operations predominate, representing 80% of NBAA members. An indeterminate number of pilots is leaving business aviation for the airlines and fewer young ones are providing infill for the future. "It's been coming for a long time," Jad Donaldson, aviation director for motorcycle maker Harley-Davidson, told *BCA*.

According to Donaldson, chairman of the NBAA's Business Aviation Management Committee (BAMC), that group has been looking at the issue for the last several years. The first BAMC Workforce Summit, convened in 2017 in Washington, D.C., was attended by 40 representatives from across the aviation industry, including business aircraft OEMs, maintenance directors, leadership of NBAA focus teams, even the airlines — in Donaldson's words, "a real mix across the community." The committee had gathered salary surveys of the major airlines, "so we knew what they were paying their people."

Committee member Dan Wolfe, who oversees Nationwide Insurance's flight

department at Columbus, Ohio, had been tracking the pilot shortage for some time and warning his colleagues there might be an exodus from business aviation to the airlines long before it began to show up. "He said that his studies had shown graduates of the top five aviation universities were not only not coming into business aviation but knew very little about it," Donaldson said. "The airlines were recruiting like the military at these schools and even offering to underwrite their educations, but business aviation was nowhere to be seen."

Lifestyle Is 'Number One'

In 2016, BAMC conducted a survey of NBAA members on pilot retention — its first — and received a sufficient response to verify Wolfe's findings. It was clear that a trend had developed. "Lifestyle was the number one reason why pilots were leaving business aviation for the airlines," Donaldson said. Pay was a distant number two, and three was professional development. "When we looked at that data, we set forth to understand the nature of the problem."

According to Charlie Priester, chairman of Priester Aviation, a major charter/management and aircraft sales operation based at Chicago Executive Airport (KPWK), the problem has always been there. "We remember when pilots were happy just to fly and be paid for it," he reminisced, "but the world has changed, and the industry has evolved, and quality of life is becoming more important. An indicator of this is that the divorce rate in the pilot community is pretty darn high — many pilots are never home when they should be — and the pilot shortage has brought it to light."

Priester cited Boeing market projection reports that for several years have predicted a "staggering" need for pilots and mechanics over the next decade — up to 400,000 pilots and the same for mechanics. "Being a pilot or a seasoned mechanic is not unlike being a doctor, in that there is 'intern time' to bring the technical knowledge together with experience," Priester continued. "Airline employment is well paying, generally stable, and offers flying or working on good equipment. Some people flying



YAKOBCHUKOLENA/ISTOCKPHOTO

Ah, but in flying — as well as in life — timing can be everything. Today, around the world, the demand for professional aviators has rarely been greater. And nowhere other than the U.S. is the need more severe as the airlines thrive and expand. Known for its cyclic nature, the airline industry is currently riding an upward surge. Business is good, Boeing and Airbus are fat with multi-thousand aircraft backlogs, and the carriers are at last hiring. And hallelujah for the current generation of aspiring airline pilots toiling in the trenches of aviation obscurity. Your time is here.

for the airlines say, 'It's a great job, but I'm bored to tears . . . but on the other hand. . . ' I've understood it when our pilots have chosen to leave for airline jobs, as I have never been able to offer the same pay or scheduling options."

The lifestyle issue — having time away from work and the flexibility to schedule it — was epitomized by a former corporate pilot *BCA* interviewed after the aviator had left his flight department for a major airline. He claimed he liked the work but mostly the ability to control his schedule so he could plan his personal life. It also saved his marriage, he said, adding that, "The money is good, too."

Dan Drohan, CEO at Solairus Aviation in Petaluma, California, insists that an airline career is not as attractive as claimed. "Some business aviation pilots are going to the airlines," he said, "but many are those who were furloughed by the airlines last time. Some came into corporate flying just to build time for an eventual move to an airline. And . . . some never wanted to be corporate pilots in the first place."

Drohan claims that when Solairus has openings for pilots, "we are over-run with resumes." But Solairus is one of the largest business jet management companies in the U.S. with a stable of 160 airplanes, including 50 Gulfstreams and an equal number of Bombardier Globals and Challengers plus numerous examples of other types, and can afford to pay top dollar for qualified captains. Further, its pilot roster stands at 600 individuals, which works out to more than three pilots per aircraft, ensuring a reasonable work schedule for all.

But the crux of the burnout problem predominantly rests with the small, understaffed operators. According to Priestester, "When we take this issue to our clients, they leave and come back and say they know someone who has two pilots and so 'Why do I need three?' We answer that two things will happen: One is that the world's changed and we have to focus on pilots' personal lives and, two, the number of days you will be using the airplane defines how many pilots you will need to maintain the flight crew's quality of life and therefore be able to retain them. If we tell a seasoned pilot it's a two-pilot airplane, they will look someplace else for a job. We have to offer a good life to our employees and convince the owners that it's important."

The airlines are beating business aviation in two areas . . . First, with transitioning military pilots . . . [and second] enticing college graduates into business aviation.

Flight vs. Duty Time

"When we hire pilots," Priestester continued, "we are hiring them to crew owners' airplanes, and the owners will want pilots with experience in the airplanes and lots of total flight time. But that has become harder to fill, because the ones we hire today want to know how many pilots come with the airplane so they can be guaranteed time off. And now, it's essential to say three pilots. For years when we've talked to owners and potential buyers, we've asked them how many hours they're going to fly a year — an industry-standard question. And the question should really be how many days do you want this airplane available to you, because that defines duty time."

A crew might have to sit at a destination for two weeks and wait for the principal to return. So, duty time is substantially more than flight time. "Generally," Priestester pointed out, "that means that 85% of the time you're away from home. We have to make that clear to the potential buyer of the airplane."

Training may be better than ever today, but the cost has increased substantially. "If you take a light jet," Priestester said, "the initial training for the pilot is \$30,000 and \$20,000 a year for recurrent. For a Gulfstream V, it's, respectively, \$60,000 and \$50,000. Now,

understand that these costs are per pilot, so double those numbers for two crewmembers." Not only is quality training a safety issue, but insurance companies require that pilots be well trained if they are to underwrite an operator.

"So, our job for the owners who want to see the same faces every day they get on the airplane is to offer a package that provides quality of life for the pilots," Priestester said. "At Flexjet and NetJets, they never know who the crew will be. So, we have to convince them that this is the cost of doing business in this field. What we are selling is a maturing industry so we have to bring it along and convince potential owners that this is good business that creates stability and attracts good people. That it's the cost of being in the game."

Industry veteran Robert Agostino, a Gulfstream G650 pilot who also heads a Texas flight operation, offers an interesting metric for evaluating the two-pilot crewing model. "Let's take two companies," he told *BCA*, "each with one airplane and two pilots. One — let's call it 'Company A' — flies 200 hr. a year, and their dispatch time is never more than 24 or 48 hr. 'Company B' flies 400 hr. a year and may fly three or four legs a day three times a week and [their pilots] are on call when they are not flying. When you look at that scenario, it appears they are very different companies. But not so. With Company A, what happens when one pilot calls in sick? They might use contract labor, but are they [contract pilots] familiar with your operation, the temperament of your passengers, SOPs, and so forth, and so have you not degraded safety? What happens when they have to go train? In a perfect world, this one-airplane, two-pilot concept would be erased."

If you can afford to buy the airplane, you should be able to afford to hire three pilots and operate safely, Agostino maintains. "The fallacy in our business is whether you can afford to fly that airplane. To own an airplane, it costs you the same if it is sitting in the hangar or flying except for the incidental costs. You have to take the total cost of ownership and approach it as covering everything you need to get what you want. The business aircraft is a force multiplier . . . but a large part of the buying process is educating

the buyer on what it will take to get what you want with adequate safety margins.”

The ‘Insurance Pilot’

“What have we learned in 50 years?” Agostino asked, then answered: “The impact of fatigue, physiology of flight, and that people have lives outside of work. At the end of the day, this should not be something people make money on — you have to accept the limitations of two pilots or plan accordingly to not fly very much. You have to approach it as having an ‘insurance pilot’ in the sense that you are providing your operation with enough staff to give them quality of life, have them in the mental state of mind and physical state of being to be operating at peak performance, and give them adequate time to train and study.” Agostino’s company, which operates a brace of G650s, has three pilots assigned to each aircraft.

“Safety is the result of operating at peak competency,” Agostino continued, “so what are my competencies? And how can you have that if you are on call 24/7? Look at what we have learned about human factors in the last 50 years: 80% of all accidents are due to human error, the same factors that cause accidents in cars, on trains, in hospitals, and so forth.”

At the end of the day, the key is to educate buyers to the business aviation environment and what is required for safe operations. “Our pilots train like astronauts,” Agostino claimed. “You can do anything once, like 24-hr. ops, but the problem is that it becomes the norm. If the potential buyer can afford the airplane, [he or she has] to make two decisions: (A) how am I going to use the airplane, that is, my expectations of the aircraft’s availability, and (B) how many people — my staff — do I need to meet those expectations?”

Thus, owners have to apply the same rules to the flight department that they apply to their businesses, which is to say, you can’t have everyone do everything. “You don’t expect your secretary to do your accounting,” Agostino said, “so you can’t expect your pilots to do everything necessary to keep the aircraft flying. There are basic rules of business that apply here. The flight department has to be seen as another business unit in the company.”

One of Agostino’s mantras is, if you think education is expensive, try stupidity. “Tell buyers to apply the same basic principles of how they run their businesses to running their flight departments. The airplanes are safe but only as safe as the people operating them. So, you want people up front who have quality lives, are getting enough flight time and are on top of the job. I talked to one charter pilot flying Part 121 freight who told me he worked 310 nights last year, and I asked him why he would do that. It’s insane.”

Retaining pilots comes down to creating an environment of communication, compromise and compensation — the “three C’s” — Drohan at Solairus believes. “These are the three critical ingredients to the perfect pilot/owner satisfaction,” he pointed out. “You need to be talking about expectations, limitations and scheduling. We all need to be willing to compromise. Owners need to be willing to give up a little here and there, especially when the expectation is always the 24/7/365 situation.”

For the pilots, the compromise is that “sometimes we will have to use that \$65

million business jet,” Drohan quipped. “In terms of compensation, I don’t typically like to compete with the airlines, as we’re talking about two different jobs. You may get scheduling predictability with the airlines, but you have set pay structures, and there’s always the risk of furlough.”

The airlines are beating business aviation in two areas, Drohan insists. First, with transitioning military pilots, who for eight years have lived with the military model, where they are told everything: what to do, where and when to fly, to wear a uniform, and so forth. And the airlines give them a similar model: where and when to fly, put on a uniform, and so forth.”

The second area is enticing college graduates into business aviation. “It’s unfortunate because, collectively as an industry, we could do better here,” Drohan continued. “We are a proud industry, often looking to hire 7,000-hr. pilots at a minimum with a college degree. But the reality is that these young aviators coming out of college with 1,500 hr. can be scooped up by a regional into the airline world.”

So, to address that, business aviation

Harley Haven

“At Harley-Davidson, we are a small flight department that does big things,” Jad Donaldson, the motorcycle manufacturer’s aviation director, declared.

“We try to be the very best. We’re a Stage III IS-BAO-audited flight department, and we spend money on professional development. Our scheduler is a licensed flight dispatcher, for example. We operate a Challenger 300 and have four pilots — I’m one of them — two mechanics and a dispatcher. I instill the life quality for our pilots, and I can substitute for a pilot who has a commitment in his personal life.”

It takes three years to break even in the development of a pilot, Donaldson said, “and if he or she stays five years, the next two years are at a price point where their support is part of the direct operating cost. The cost to keep people is so high you do not want to lose them.”

Eighty percent-plus of NBAA members operate a single aircraft, Donaldson pointed out. “The people starting to feel the pain are these one-aircraft operators — if you have two pilots and one quits, you’re out of business. Rental pilots can help in a pinch, but that is a temporary solution. They don’t know the SOPs for that operator, the CRM and the relationships.”

We were compelled to ask Donaldson about Harley-Davidson’s recently announced all-electric Harley. “It’ll knock your socks off,” he said. “It sounds just like a jet!” **BCA**

needs to be more willing to accept on-the-job training for young aviators. “What if every large-cabin operator were willing to hire one additional pilot in his or her early 20s and pay them what a commuter airline pays just to be in the industry and gain experience?” Drohan speculated. “We have to solve our own problems and stop blaming the airlines and start getting creative. And addressing the quality of life issue, adding a third pilot can

mitigate a lot of stress for the pilots already there. The airlines are adapting by changing their model to hiring people with less experience and training them.”

A Formula for Retaining Personnel

Increasing headcount is relatively less expensive than dealing with turnover.

“One of the reasons why we believe we [at Solairus] have been effective in retaining our people is that we create a work environment with the tools, resources and infrastructure to make the job and process more pleasant,” Drohan explained.

“Our crews feel less that they are on an island and more that they are part of a team. There are people who are cut out for this and there are those cut out for the airlines. Business aviation appeals more to people with a sense of adventure and

Big Data

“The only way to get a good understanding of the problem is data — data that is vigilantly collected and is recorded and retained for further analysis.”

The speaker is Sheryl Barden, president and CEO of Aviation Personnel International in San Francisco. Daughter of API founder Jan Barden — both women are well known in business aviation circles for pilot employment assistance — she was addressing the work/life imbalance issue in business aviation flight departments that is causing pilots, mechanics and schedulers to seek employment elsewhere. Implicit in the on-call nature of business aviation — the requirement in many cases to be available for work 24/7 and the inability to plan a personal life — the lifestyle can result in prolonged stress and, ultimately, burnout.

Barden received a different perspective on the work/life balance when she chaired a panel on the subject at this year’s NBAA Schedulers & Dispatchers Conference. There, she was exposed to the experiences of flight department schedulers working constantly on-call, or nearly so. Schedulers are the unsung heroes of business aviation operations, often unseen, and are always offering support for flights in progress, no matter where their crews are or the time zones they ply.

“When does a global 24/7 operation stop?” Barden asked in a report she wrote after the conference ended. “When does the phone stop ringing? The answer is, it doesn’t.” While these operations run constantly, Barden wrote, “human beings cannot keep that pace.”

Microsoft founder Bill Gates may have been “a 24/7/365 kind of guy when he built and ran one of the largest companies in the world,” Barden wrote, “but the bulk of us are not manically driven entrepreneurs like Bill. We’re expected to leave work one day and come back refreshed on the next. So, we cannot be up working in the middle of the night and be expected to show up the next morning fresh as a daisy.”

Barden is a believer in data-driven solutions. Interviewed by *BCA* after the conference for her thoughts on the work/



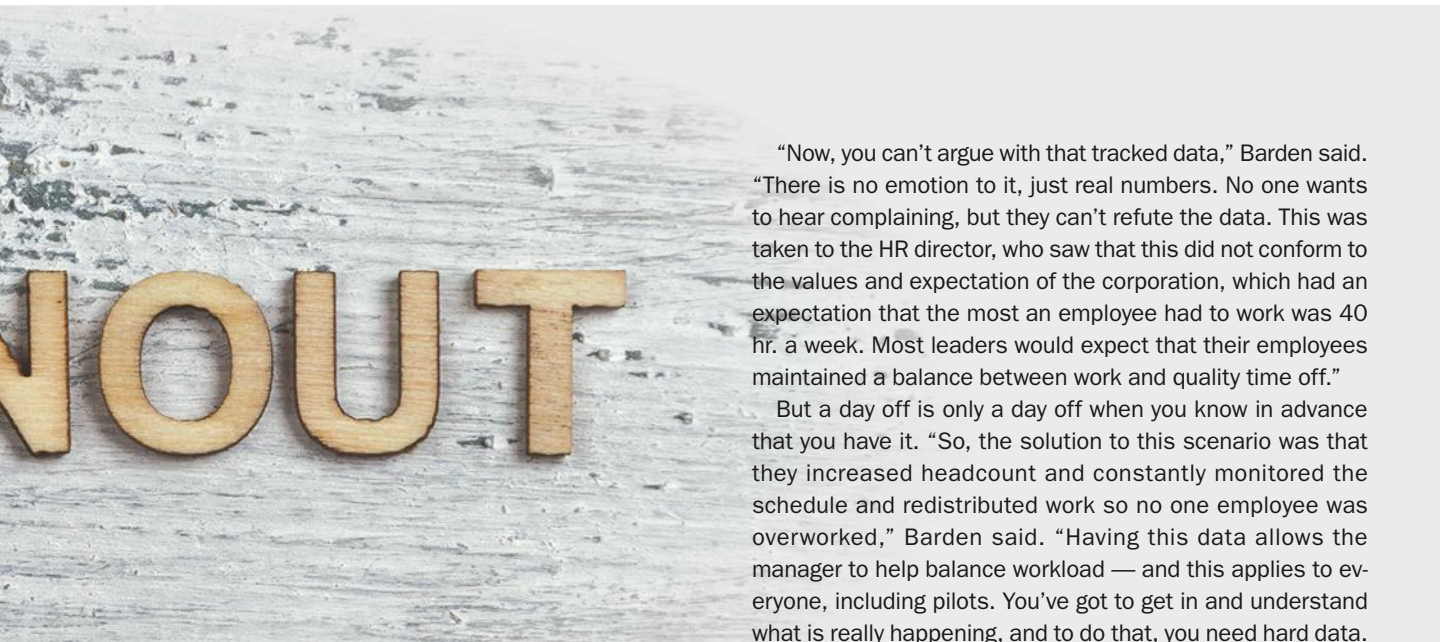
life balance issue, Barden insisted that “because we are living in a data-driven world, without accurate data, no one is going to move the needle toward a solution.” She cited “a multi-aircraft East Coast operator” that applied data to help resolve a lifestyle problem with overworked flight schedulers. “That was something that could be translated to any role in the flight department,” she said, including pilots. By keeping a vigilant record, it’s possible to see where workload is impacting people, with consequent fatigue buildup over time. In other words, the data can begin to tell a story. “And when you see that story,” Barden asked, “where does it line up with the values of the host organization?”

This was critical in the analysis performed by the aforementioned East Coast flight operation. “What was happening was that people felt they were on 24/7 call, but no one knew when or how much they were working, as not all work happened in the office,” Barden explained. “They were getting midnight calls to solve problems with overseas flights, pulling their cars off the road to use their laptops to handle situations,

appetite for less structure and rigidity in scheduling and workflow. And there are people who are inspired by their client's mission and like the variability in destinations. And, as well, it's also the personal connection between the client and the crew. We like to work with people who are changing the world we live in — it gives us a sense of meaningfulness. We gotta' start solving our own problems. Why aren't we doing our own job fairs like the airlines and military?"

Harley-Davidson's Donaldson says he doesn't "rag on the airlines; they're just different from us, and we both fly airplanes. There is not a lot of good career leadership and guidance now in business aviation. I've always emphasized mutual respect and quality of life, but if you want to leave for more money, that's fine. Everyone needs to be fully aware of what they want out of their career and what is important. If it's just money, then go to the airlines.

"If you don't want customer interaction and customer service," he continued, elaborating, "and to fly the latest equipment with the best avionics, have the freedom and flexibility to fly in different regimes, and do not want to have to make a lot of decisions about the flight, then go to the airlines. We have to meet passenger needs, ensure the safety of flight, file the flight plans, check the weather, make sure all our performance data is correct, go to different airports instead of



REPHOTO/ISTOCKPHOTO

working at night, on weekends, on holidays. The net of it was that no one would articulate what the situation really was in terms of hours worked and schedule. These people were burning out, and the stress level was affecting home lives and families. And this can happen in any career, whether scheduler or pilot, maintenance manager or cabin attendant."

Boss, We Have a Problem . . .

So, the flight operation's scheduling manager accepted that they had a problem and needed data in the form of hours worked and when to fully understand the problem and make a case to upper management for a solution. Typical of data collected were statements like, "I worked in the office 8 hr., went home and had to get up at 2:00 a.m. to work a flight in progress for 2 hr. and then couldn't get back to sleep for 90 min. and then had to get up at 6:00 to go back to the office."

The scheduling manager compiled the data and brought it to the aviation manager, whose reaction was, "This isn't right, and we need to make a change."

"Now, you can't argue with that tracked data," Barden said. "There is no emotion to it, just real numbers. No one wants to hear complaining, but they can't refute the data. This was taken to the HR director, who saw that this did not conform to the values and expectation of the corporation, which had an expectation that the most an employee had to work was 40 hr. a week. Most leaders would expect that their employees maintained a balance between work and quality time off."

But a day off is only a day off when you know in advance that you have it. "So, the solution to this scenario was that they increased headcount and constantly monitored the schedule and redistributed work so no one employee was overworked," Barden said. "Having this data allows the manager to help balance workload — and this applies to everyone, including pilots. You've got to get in and understand what is really happening, and to do that, you need hard data. And with it you can make sound decisions versus emotionally based decisions."

Barden is also a believer in having an elastic workforce including one or two regular contractors the operation can turn to as a pressure relief valve. "Whether that's in scheduling, maintenance, the cabin or the cockpit, when you have those people who are trained to your standards — regular contractors — you can use them to help bring along life balance, not just as a last-resort fill-in."

Barden also had some observations on the pilot shortage and business aviation aviators leaving for airline jobs: "You start with reserve and are on constant call, so it isn't immediately better. People go to the airlines to get what they think they'll get in the future. Many are taking pay cuts initially.

"The issue now is that we can't depend on the regional airlines to get pilots for business aviation thanks to the quick flow-through from the regional carriers. Do we offer an attractive enough opportunity? Attracting new people to our industry is going to be the challenge. We have to help young aviation professionals learn how attractive our industry is. **BCA**

the same predetermined set, all without a dedicated dispatching department. Personally, I like that, but not everybody does.”

But there’s a caveat: “You will be paid a good salary in business aviation, but sometimes the drawbacks will be the demands on your time because the job does not come with a schedule like airline flying. That being said, most businesses that operate aircraft do so around their own corporate schedule, meaning they have busy times of the year and not-so-busy times.”

Avoiding ‘Groundhog Day’

Business aviation is viewed by the rest of the industry as competent and reliant, Donaldson asserted, adding, “As a person who wants to be involved in aviation, you need to be self-aware of what you want to do for a career. The airline life — a rigid, standardized process to the same collection of airports — is ‘Groundhog Day’ every day. Lots of airline pilots game the system, but you can’t do it in business aviation, which pays a straight salary with a good pension.”

One business aviation pilot — who shall remain anonymous — found this out when he left his corporate flying job for a posting with a major airline but eventually returned to his former flight department because he liked his colleagues there and the family-like work environment. They flew together, knew each other’s strengths and foibles, and hung together at destinations, whereas post-flight at the airlines, everyone went his or her own way until they checked in for the next leg.

In the BAMC survey, the NBAA found that Gulfstream and Global pilots were holding down the same salaries as 12-year captains at a domestic airline, “which is why we believe that the survey was presenting us with the correct information,” Donaldson said, “and that money was not the number one driving fact: It was quality of life. Of course, there are outliers, but they’re in the minority according to the survey.” BMAC has conducted two surveys so far — the first in late 2016, followed by another the following year — and is now planning a third. The first one went to 11,000 pilots in the NBAA and had 1,700 respondents, considered sufficient to obtain good data.

The second BAMC Workforce Summit in summer 2018 broadened the

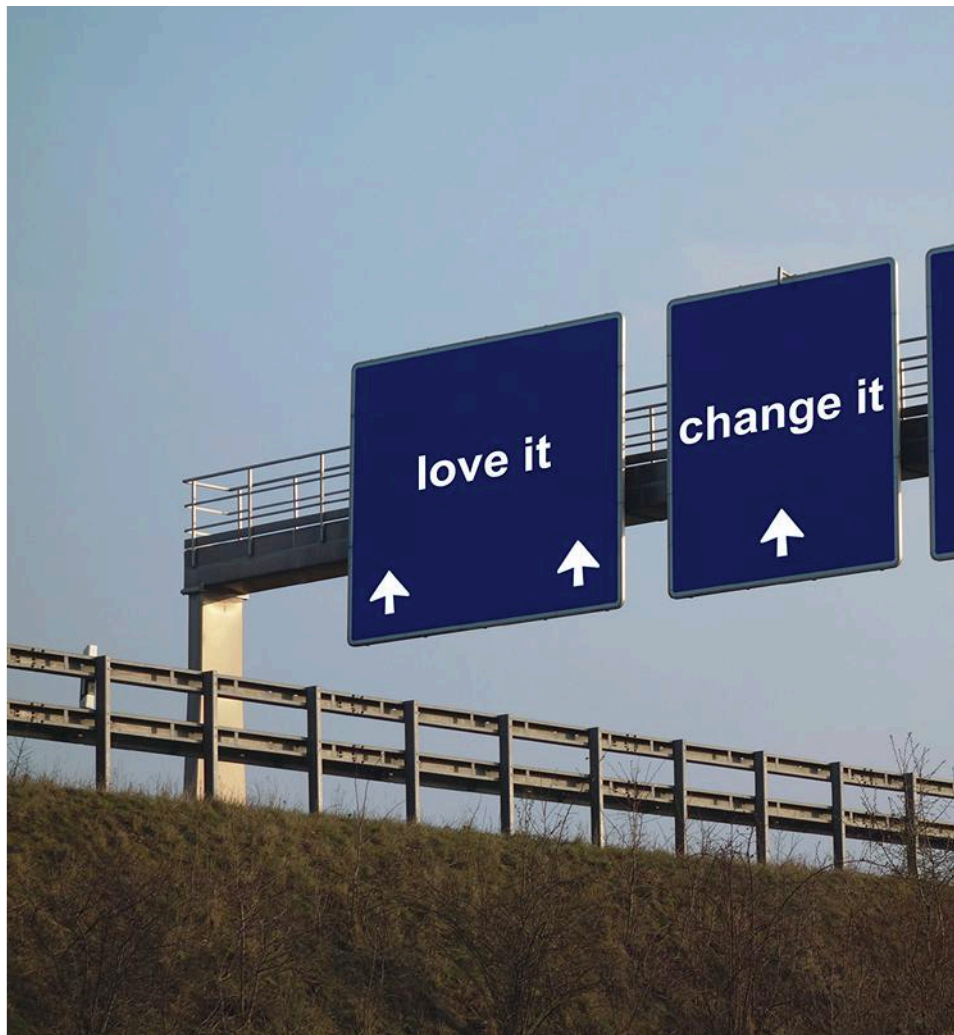
Committee’s reach in the aviation advocacy community by inviting the National Air Transportation Association (NATA), Aircraft Owners and Pilots Association (AOPA) and NBAA leadership. “We are looking for solutions,” Donaldson said. “There are long-term and short-term problems. The long term is that we are behind the curve on what the airlines are offering by not educating students on what business aviation has to offer.”

Consequently, BMAC has created a PowerPoint presentation and videos on business aviation careers for pilots, maintenance techs, management, dispatching, facilities and aircraft. “That’s the grassroots effort,” Donaldson said. “We learned that the AOPA has funded over 90 high schools across the country to build aviation programs to teach young people about getting into aviation and understanding all aspects of it.

We are building a partnership between the NBAA and the operators to help backstop the AOPA high-school initiative. And we are enlisting flight departments to assist teachers.”

For my generation of aspiring airline and corporate pilots, living on borrowed money and getting their wits scared out of them every day as flight instructors, the current rush and well-paid offerings, for airline positions is almost insulting. But it’s what the traffic will bear in high tech and banking, and as Donaldson said, you really have to know what you want in a career, and we might add, be willing to make sacrifices, if necessary, to get it.

Meanwhile, British and many European legacy airlines have long primed their pilot pipelines with suitable zero-time candidates, whom they’ve hired, and enrolled in ab initio flight training through commercial/multi-engine/



instrument certification. Flying the line at some carriers, the newly minted aviators reimburse the cost of their training via payroll deductions. While some airlines, particularly the British carriers, have traditionally hired candidates out of universities, others are taking them right out of the gymnasias (Euro high schools), thus benefiting from four extra years of productivity that otherwise would have been lost in academia gaining baccalaureate degrees. The candidates – assuming they are able to master the nonstop total-immersion ab initio training and pass their check rides – of course, reap the benefits of rewarding careers in a (predicted) growth industry.

The pilot shortage is real and will continue, Charlie Priester insists. “In my opinion, I don’t think this will get any better very quickly. The pilot shortage . . . will go on, as will the mechanic shortage, which is just not getting the same level of publicity. Right now, the airlines need pilots so urgently that some will pay pilot students still in school a signing bonus of \$10,000 and start them, once they’ve graduated, at \$75,000. And even then, they can’t get enough pilots to sign up. It’s supply and demand.” **BCA**



PATTILABELLE/ISTOCKPHOTO

Left-Side Accounting

The flight department has to create value, believes Gary Dietz, chief pilot for a multi-aircraft flight department serving a major Southwest corporation engaged in international operations.

“We try and run four pilots per airplane,” Dietz told BCA, “but the reason is that it allows consistency in training and on the flight deck, and it provides a small margin of predictability in a non-predictive enterprise [i.e., the ad hoc nature of business aviation]. We create value in business aviation by creating predictability for the executives, and that keeps us on the left side of the balance sheet. If we hired the same number of pilots per aircraft as the airlines do, our operation’s cost would be excessively high.

“We have to find that value, and that’s determined by the number of days a pilot flies,” Dietz continued. “We have to factor in the days, hours and overnights. The difficulty for a small flight department is that they have smaller margins and fewer resources from which to draw. And the av managers of the smaller operations that do not have the scale the larger ones have, I can empathize with.”

To create that value while retaining pilots and ensuring a balance between their work and personal lives is a daily challenge for an aviation department manager. “As the av manger, you have to make a case for the value that the aircraft and the people who crew, maintain and schedule it provide to the company,” Dietz said. “And the corporation’s principal has to have expectations of what value he or she wants and has to be able to listen and be open to solutions to support the value proposition.”

It’s really about institutional culture, Dietz believes. “And the av manger has to show the value to the company by managing the bottom line while at the same time creating resources in the department that allow some predictability in an unpredictable schedule.” This includes the provision of vacation days, hard days off, defined times of availability on the road or at home, and maybe allowing longer weekends when the schedule permits. Each department has to work this out in a way that does not create excessive expense for the company.

“In our shop,” Dietz continued, “we have a 2.5-hr. callout for popup flights. We define the difference between being accessible or available. Everyone has to be accessible, unless they are on vacation or an approved day off, but a certain number, at different times, are required to be available, or on-call. As manager, I own it. I have to manage the schedule to know how many people are available at any given time. We want to provide our crewmembers with options on how they can manage their personal schedules while we, as the leadership team, must manage the flight schedule.” **BCA**

Bombardier Global 7500

A bespoke, personal flying flagship **without equal**

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

The \$75 million Global 7500, a near-clean-screen design, is the largest, roomiest, farthest flying and most expensive purpose-built business jet yet created by a general aviation manufacturer. It represents a wholesale shift in large-cabin aircraft marketing by Bombardier, as the Montreal firm redirects its focus toward people of means who value life-style and comfort as much as mobility and utility.

Long ago, Bombardier saw the emerging shift in buyer demographics. While the world's largest corporations reined in their purchases of long-range, large-cabin business aircraft in the aftermath of the Great Recession of 2008, interest in uber-jets perked up among ultra-high-net-worth individuals. And these fortunate few increasingly have the means to acquire aircraft in this price range. Unlike CEOs of large public corporations, these well-heeled individuals don't lose sleep over hostile shareholders, corporate raiders

or social justice warriors blocking their doorsteps.

Forbes magazine reports that there were about 1,100 billionaires in 2008. Today, there are more than 2,200 people in the publication's "triple comma club." Collectively, they're worth more than \$9 trillion. They own multiple luxury vehicles, reside in multiple homes and move between multiple destinations. They cherish the safety, security and solitude afforded by private jets while traveling through a world that prizes paparazzi, pawing and prying.

The Global 7500 ups the appeal for such discerning buyers by flying nonstop at Mach 0.85 between cities as distant as 7,700 nm, such as Buenos Aires and Brisbane; Mumbai and Morristown, New Jersey; San Francisco and Singapore; or Sydney, New York and Hong Kong. In March 2019, for instance, the Global 7500 stretched its legs on a record-setting 8,152-nm trip from Singapore to Tucson, Arizona.



The aircraft's main cabin is one-third longer than any model offered by Dassault or Gulfstream, providing space for a fourth seating section. Heretofore, typically configured large-cabin aircraft have offered three-section layouts. Zone 4 in the base-line Global 7500 has a 16 G-rated, three-place divan, single chair and worktable. Looking from front to rear, Zone 1 is a four-chair club section with 21-in.-wide seats; Zone 2 is a six-place conference grouping with two facing chairs on the right and four facing chairs on the left; and Zone 3 has a 16 G-rated, three-place divan on the left, plus a padded perch for part-time occupancy in front of the emergency exit adjacent to a credenza with life raft stowage inside, inflight entertainment (IFE) media center and a top-mounted 32-in. monitor.

Aboard Bombardier's s.n. 70006 demonstrator, accommodations are not so Spartan. Bespoke cabin options include wider and plusher chairs in the club suite, wine refrigerator/chiller/freezer, warming drawer, and coffee and espresso makers, plus wood veneer flooring for the galley, additional bulkhead separator between Zones 2 and 3, stone veneer flooring in the aft lavatory and larger flat-screen IFE monitors, airport moving map surface management system and various other avionics options. Yet even with all the added kit, s.n. 70006 can still carry eight passengers with full fuel.

Optional, but not installed on the demonstrator, are a 300-lb. aft lavatory shower with 32-gal. (252-lb.) water tank, 345-lb. super-soundproofing kit, 15-lb. electrically powered divan and 40-lb. second head-up display in the cockpit.

The heft and muscle of this titan pay off when ordering weighty options. Each 100 lb. of added empty aircraft weight

reduces its eight-passenger range by only 16 to 17 nm. What better way to whisk the family between its Royal Dutch Feadship at the Monaco Yacht Club and its Jackson Hole ranch estate at nine-tenths the speed of sound, all while cossetting those on board in unequalled comfort?

Although Bombardier makes no apologies for catering to the carriage class, it also wants the Global 7500 to appeal to corporate aircraft buyers. To that end, the aircraft's modular cabin design enables buyers to pick-and-choose different layouts for each of the four 9-ft. seating areas, providing a choice of 10,000 distinctive floor plans.

A corporate operator, for instance, might choose back-to-back, four-chair club sections in Zones 1 and 2, a four-seat conference grouping along with three-place divan in Zone 3 and a three-place divan plus single chair for Zone 4. And while the Global 7500 is typically configured with 14 to 17 seats certified for full-time occupancy, its primary mission is to carry eight to nine passengers in unmatched comfort on voyages of up to 16+ hr.

To help customers visualize all the layout possibilities, Bombardier offers a tablet computer app that enables them to move various seating and sleeping configurations into each of the four sections at the swipe of a finger on the screen. Because of the four-zone interior, the aircraft is one of the few purpose-built business jets that can comfortably sleep eight passengers in pairs of facing chairs or on foldout sofa sleeper divans.

Notably, none of the four-section seating choices impinges upon the forward crew rest area, designed from the outset to meet SAE 4101 Class 1 sleeping compartment requirements.



Bombardier's \$75 million flagship is the largest, longest range, roomiest and most luxurious purpose-built business aircraft yet to make its debut.

The left-side crew rest compartment has two windows, and one fully reclining crew chair and ottoman that convert into a 6.6- by 2.5-ft. berth. The compartment can also be fitted with upper and lower bunk beds.

The crew suite also has its own lavatory with window, a full galley and crew wardrobe closet. The lav has been moved from the front of the galley on older Globals to the rear of the Global 7500, providing better access for passengers and more space for a crewmember on the cockpit jump seat.

Breaking With Older Family Members

While BD-700-2A12 Global 7500 is grandfathered onto the original 1998 BD-700-1A10 Global Express type certificate, it shares little in common with older members other than its exterior fuselage diameter and a primary airframe made of metal. Lithium aluminum alloy, instead of older zinc or copper blends, is used for large parts of the structure to save weight. While the original aircraft was certified to FAR Part 25 through Amendments 91, 94, 96 and 97, the new model is certified to FAR Part 25 Amendment 138 with no exceptions.

It has a new, larger and lower-drag wing optimized for Mach 0.85 cruise speeds, thinner fuselage frames that increase usable cabin width and height by 1 in., and 80% larger cabin windows, along with new General Electric Passport engines, new full-FADEC Safran APU approved for unattended ground operation, and new fly-by-wire (FBW) flight controls originally developed for Bombardier's C-Series regional jets, plus a recontoured fuselage nose cowl to reduce transonic drag and noise, and new aft fuselage and empennage. Its Global Vision Flight Deck is more capable and more fully integrated with the new turbofans and updated systems. In short, pilots will need new type ratings and will need to pay close attention in ground school.

This starts with different limit speeds. Glance please at the accompanying specifications table. Bombardier dive-tested the aircraft to as high as 370 KIAS and 0.995 IMN. Redline Mach is 0.925 and the aircraft maintains that MMO up to its 51,000-ft. certified ceiling, in large part due to the automatic flight envelope protections built into its FBW system. One-engine-inoperative (OEI) service ceiling also goes up from 18,000 ft. to 25,000 ft., compared to the Global 6000. It's now in league with best in class big twins from Savannah.

The aircraft's weight and size make possible its exceptional cabin comfort and unmatched range in class. But its 104-ft. wingspan and 57-ton mass may make it unwelcome at some airports. Colorado's Aspen-Pitkin County Airport/Sardy Field (KASE), for example, has a 95-ft. wingspan limit and Teterboro Airport (KTEB) in New Jersey restricts weights to 100,000 lb. In addition, the Global 7500 AFM recommends 100-ft. minimum runway widths.

The 1,254-sq.-ft. wing is smaller in area than that of the Gulfstream G650ER and the aircraft's MTOW is 11% higher. Power loading is nearly identical. But the Global 7500's high-lift system, including leading-edge slats and double-slotted inboard Fowler flaps, gives the aircraft the best sea-level, standard-day runway performance of any aircraft in its class, as shown in the accompanying Range Vs. Payload chart.

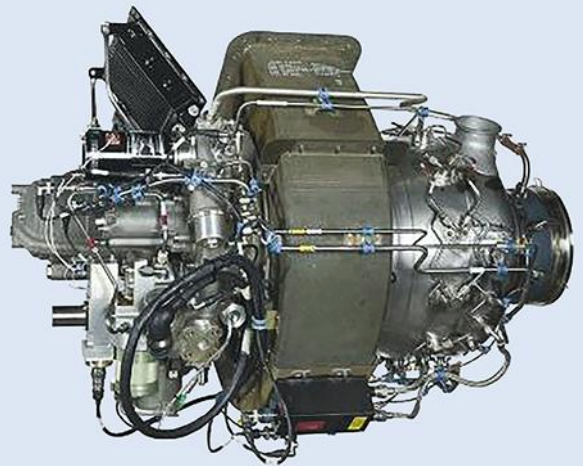
Historically, ultra-long-range Gulfstreams have beaten the Globals on range performance when departing hot-and-high airports. Not so with the Global 7500, particularly because of its higher-pressure-ratio turbofans. On warm days, it will surpass the G650ER's max range when departing Chicago Executive (KPWK), Key West International (KEYW), Bern, Switzerland (LSZB) or Toluca, Mexico (MMTO). Wet runway

conditions only widen the spread in range performance between the two aircraft because of the Global 7500's lower V speeds and shorter takeoff field lengths. Departing *BCA's* 5,000-ft. elevation, ISA+20C airport on a 6,400-nm trip, the Global 7500 even needs less runway than the three-engine Falcon 8X.

The wing has virtually the same 35.3-deg. quarter chord wing sweep as older Global jets, but it has a thinner thickness-to-chord ratio, leaner flap track fairings, improved lift-to-drag performance, more efficient winglets and as much as 30% better low-speed lift performance because of double-slotted, inboard Fowler flaps.

The wing structure is exceptionally flexible for a general aviation aircraft. Couple that to its 91 lb./sq. ft. wing loading and FBW active load alleviation and the predictable result is one of the softest rides in the air, based upon our observations while flying through frisky winter jet stream turbulence over western Kansas.

The new model is Bombardier's first FBW business aircraft. It uses well-proven C*U control law, similar to the Airbus A220, Boeing 787, Embraer E-Jets and Gulfstream FBW models. C-star blends G command feedback (vertical acceleration)



First Business Aircraft for Safran's SPU300

The FADEC-equipped SPU300[BA] has the highest power-to-weight ratio of any engine in its class and boasts an exceptionally wide operating envelope. It can be started on the ground up to 14,000 ft. and in the air up to FL 450. It can start the main engines up to FL 230. It can supply bleed air for cabin heating, air-conditioning and pressurization, plus fuel tank inerting, up to FL 250, full 60-kVA AC electrical power up to FL 450 and 40 kVA up to FL 510. However, use of the APU in flight causes a slight increase in drag and results in a 1.1% range loss.

Fuel flow is approximately 180 lb./hr. The APU is housed in a fire isolating compartment and it is approved for unattended operations on the ground. The FADEC has a health monitoring function for fault detection and failed component identification. **BCA**

at higher speeds and pitch-rate command feedback at lower speeds, including during takeoff and landing. The U function is artificial speed stability, essentially meaning that “you,” the pilot, must retrim the aircraft, using a split rocker switch on top of the sidestick, in the pitch axis as speed changes to maintain the desired nose attitude. A bug on the PFD airspeed tape indicates the neutral pitch trim speed when the aircraft is being manually flown. The bug vanishes with the autopilot engaged.

The primary cockpit control inceptors are semi-active sidesticks and rudder pedals. While the left and right sidesticks are not electronically or mechanically interconnected, they have soft and hard stops, separated by a step-up in spring resistance to movement. The soft stop corresponds to aircraft operational flight envelope limits, while the hard stops take the aircraft to its structural limits. The sidesticks also feature stall-warning stick shakers and centering latches that engage when the autopilot is in use. Forcing the sidestick out of its center latched position disengages the autopilot.

The rudder pedals are mechanically interconnected, but they have no mechanical links to nose wheel steering (NWS), wheel brakes or rudder. Instead, they send electronic inputs to the NWS, FBW system and brake-by-wire systems. Springs provide tactile feedback. A rudder trim knob on the center console eases pedal force during OEI flight. Aileron trim is automatic during normal operations.

Triple-redundant primary flight control computers (PFCCs) use inputs from cockpit inceptors, control surface position sensors, the IRS and air data systems and internal flight envelope and structural limit maps to calculate required commands to the flight control actuators. Eleven remote electronic units (REUs), providing three or four levels of redundancy in each axis, process inputs from the PFCCs and then send commands to electrohydraulic power control units (PCUs) attached to the ailerons, multifunction spoilers, rudder and elevator, plus the dual-channel motor controller for the dual horizontal stabilizer jackscrew actuators. If all the REUs fail in a single axis, an alternate flight control unit sends commands to a single rudder, elevator and aileron PCU, plus one channel of the horizontal stab motor controller. This is a belt-and-suspenders, plus Velcro, design approach to keeping your digital pants on.

The robust, redundant design of the system makes loss of normal control law functioning highly unlikely. But if it occurs, the system reverts to “direct control law,” sharing much in common with “alternate control law” modes of other manufacturers’ FBW systems. Most Global 7500 direct law modes provide structural envelope protection and yaw damping, if not near full normal control law functioning, but autopilot is not available. Notably, the aircraft can be flown at its normal Mach 0.85 cruise speed in direct law with virtually no operational limitations outside of RVSM airspace.

Normal control law features include pitch and bank limiting, roll rate limiting and overstress, overspeed and stall protection, plus partial yaw compensation for thrust asymmetry, tail strike protection, active wing load alleviation and outboard/inboard aileron splitting to reduce wing bending moment, along with CG compensation to normalize feel at forward- and aft-CG extremes.

Direct law retains rate damping in all three axes; rudder and elevator limiting to prevent overstress; pitch, roll and yaw trimming; and aileron/rudder interconnect with slats/flaps extended to prevent adverse yaw.

The four-position slats and flaps are electrically actuated separately from the FBW primary flight control system. The aircraft normally has such short takeoff field length (TOFL) requirements that having enough runway at most airports is

Bombardier Global 7500 Specifications

BCA Equipped Price \$75,000,000

Characteristics

Wing Loading 91.0
Power Loading 3.04
Noise dB(A) 91.6/80.3/88.8

Seating 2+17/19

Dimensions (ft./m)

External 111.17 (33.88 m) long x
104.0 (31.71 m) wide x 27.0 (8.24 m) high

Internal

Length 54.3/16.5
Height 6.2/1.9
Width (maximum) 8.0/2.4
Width (floor) 6.8/2.1

Thrust

Engine 2 GE Passport 20-19BB1A
Output/Flat Rating OAT°C 18,920 lb. ea./ISA+15C
TBO OC

Weights (lb./kg)

Max Ramp 115,100/52,209
Max Takeoff 114,850/52,096
Max Landing 87,600/39,735
Zero Fuel 67,500/30,618
BOW 61,700/27,987
Max Payload 5,800/2,631
Useful Load 53,400/24,222
Executive Payload 1,600/726
Max Fuel 51,503/23,362
Payload with Max Fuel 1,897/861
Fuel with Max Payload 47,600/21,591
Fuel with Executive Payload 51,503/23,362

Limits

MMO 0.925
FL/VM0 FL 350/320
PSI 10.3

Climb

Time to FL 370 20 min.
FAR 25 OEI Rate (fpm) NA
FAR 25 OEI Gradient (ft/nm) NA

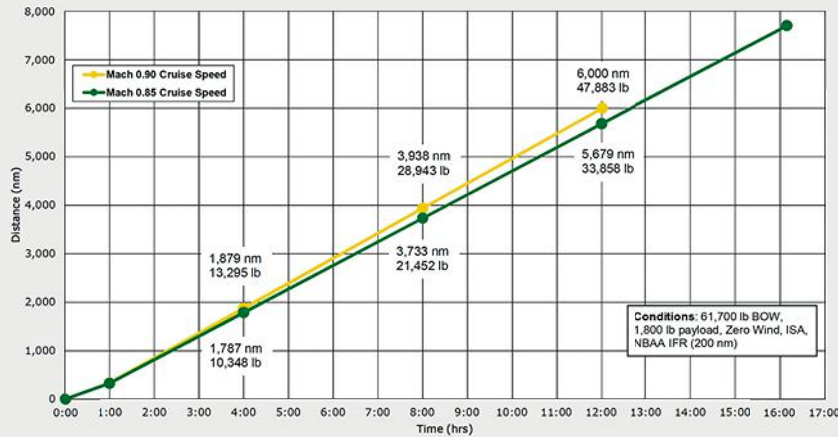
Ceilings (ft./m)

Certificated 51,000/15,545
All-Engine Service 43,000/13,107
Engine-Out Service 25,000/7,620
Sea Level Cabin 30,125/9,182

Certification ANAC/FAR 25A138
EASA CS25A13
2018

Bombardier Global 7500 Performance

Time and Fuel vs. Distance

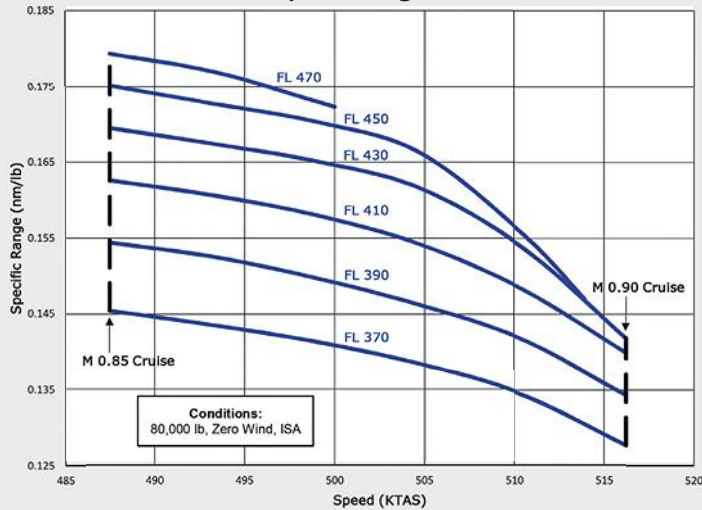


These graphs are designed to illustrate the performance of the Bombardier Global 7500 under a variety of range, payload, speed and density altitude conditions. Do not use these data for flight planning purposes because they are gross approximations of actual performance. However, spot-checks of these data during our demonstration ride correlated closely with Bombardier's performance projections.

TIME AND FUEL VERSUS DISTANCE

This graph shows the relationship between distance flown, block time and fuel consumption. The Global 7500's advertised range is 7,700 nm at Mach 0.85, but the aircraft can also fly 6,000 nm at Mach 0.90. Bombardier's 61,700-lb. spec BOW, including four crewmembers and furnishings, appears to be representative of regular production aircraft without options. The aircraft on which we flew for this report had a 61,879-lb. BOW, including upgraded chairs, "zig-zag" six-seat conference grouping, additional IFE units and a full-size bed in the aft cabin.

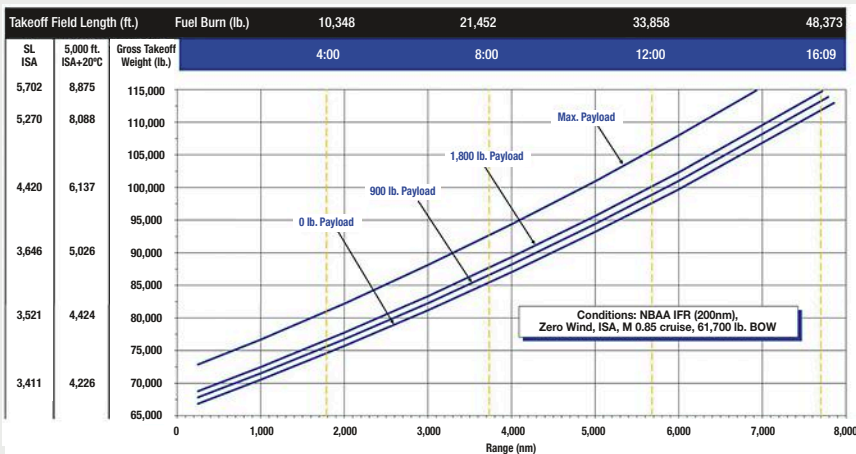
Specific Range



SPECIFIC RANGE (MID-RANGE WEIGHT, ISA)

This graph shows the relationship between cruise speed and fuel consumption for the Global 7500 at representative cruise altitudes for a mid-weight aircraft. We did not have the opportunity to verify all these data during our evaluation flight as winter weather and jet stream currents biased the results during our demo flight.

Range/Payload Profile



RANGE/PAYLOAD PROFILE

The purpose of this graph is to provide simulations of various trips under a variety of payload and two airport density altitude conditions, with the goal of flying the longest distance at high-speed cruise. Each of the four payload/range lines ends at the maximum range for each payload condition. The time and fuel burn dashed lines are based upon Mach 0.85 cruise and 33% MAC CG. Runway distances for sea-level standard day and for BCA's 5,000-ft. elevation, ISA+20C airport accompany the takeoff weights, assume the optimum slats/flaps configuration.

not a challenge. OEI first-segment climb performance, though, can be limiting when departing particularly hot-and-high airports. Given sufficiently long runways, Bombardier provides increased takeoff V speed procedures that enable crews to trade off longer TOFLs for better first-segment climb performance.

Similar to older Global jets, the Model 7500 has three, 3,000-psi hydraulic systems. The left (1) and right (2) sides have engine-driven pumps. The left side (1) also has an AC electric pump. In place of the right-side AC pump, the new aircraft has a left-to-right power transfer unit. As before, the center (3) system is powered by two AC electric pumps. System 3 also can be powered by a pump on the ram air turbine down to 110 KIAS.

The landing gear, thrust reversers, primary flight controls, nosewheel steering and wheel brakes are hydraulically actuated. Up to 9 deg. of steering is available through the rudder pedals and 82.5 deg. through the left-side tiller. Standard equipment includes an autobrake system, tire pressure and brake temperature monitoring. The brake-by-wire system also stops the main wheels when the gear is retracted, provides locked wheel detection and skid prevention, and it prevents the brakes from being applied if wheel speed is lower than 35 kt. on landing touchdown.

The electrical system also has been changed and it's been simplified. As before, the engine-driven 115-volt AC generators are direct-drive, variable frequency units. Single, 60-kVA generators replace the dual 40-kVA generators on each engine. Permanent magnet generators that supply emergency power to the FBW control system replace the second generators on the engines. The APU powers a third 60-kVA generator that

provides full power up to 45,000 ft. and two-thirds power up to 51,000 ft. External AC power may be connected to the aircraft through a receptacle aft of the right wing root. As with older Globals, the RAT generator is rated at 9 kVA down to 110 KIAS. The engines also have permanent magnet alternators that power the FADECs after engine start.

Three AC to DC transformer rectifier units (TRUs), each with twice the power of TRUs on older Globals, provide power to the main 1 and 2, essential 1 and 2 DC buses. Gone are the AC-powered battery chargers. The essential 1 DC bus charges both the avionics and APU start NiCad batteries, each now rated at 28 AH. Bombardier originally planned to use lithium-ion batteries, but the technology had not matured sufficiently before design freeze.

As with older Globals, there are scant few physical circuit breakers. Most circuits are supplied by solid-state power controllers. The left and right stand-alone SSPC control panels are gone, as control functions are integrated into an avionics system synoptics page.

The fuel system has virtual mirror image left and right sides, each with collector, surge, inner, outer, center and aft bladder tanks. Dividing each wing into inner and outer sections allows fuel to be transferred aft for CG control and reduction of wing bending moment.

The entire fuel system has only six pumps, instead of 10 in older models. Each side has an AC primary and DC auxiliary pump, plus a combined DC CG transfer and cross-flow pump. The AC pumps have been removed from the aft fuselage tank, replaced by jet pumps that use motive flow supplied by the engine-driven fuel pumps. Motive flow from the engines also

Vision Powered by Collins Pro Line Fusion

The Global 7500 flight deck has four, 14- by 11-in. landscape-configuration flat-panel displays, large enough so that each can be split into two or more windows. Dual trackball devices on the center console support point-and-click graphical flight planning and cursor movement between screen fields for data entry.

The digital flight guidance system provides outputs for the flight director, autopilot, autothrottles, yaw damper and pitch trim. It's capable of Category II approach operations and incorporates an automatic emergency descent function.

The standard package includes a paperless chart feature, synthetic vision PFDs, interactive electronic checklist and external videocam display capability. It also includes three VHF communication transceivers, including one used to support ACARS, AOC, FANS 1/A+, CPDLC and ADS-C, two



HF transceivers, a SELCAL system and Iridium satcom, plus cockpit handset and dual-channel interphone. Dual GPS-synchronized clocks, CVR, FDR, ELT, a single HUD with both synthetic vision and third-generation EVS displays, and solid-state weather radar are standard.

Dual integrated flight information system file servers, smart probe air data system, triple IRS and triple

FMS, plus dual SBAS GPS, VHF and ADF receivers, dual DME transceivers, along with ADS-B Out, TCAS, dual radio altimeters and TAWS are included.

Options include a second HUD, ADS-B In, two additional external video cameras, a security system, a second ACARS data-link and cockpit printer, plus surface management system moving map, third file server and data-link graphical weather using either Universal Weather, Honeywell GDC, ARINCdirect or XM satellite radio. **BCA**

Pilot Report

supplies a heated fuel return system that recirculates warm fuel to the wings to prevent cold soak gelling at altitude. A fuel tank inerting system, using engine bleed air processed through a molecular sieve filter, floods the center wing and aft bladder tanks with nitrogen enriched air to prevent possible ignition of fuel vapors. Normal fuel system operation, including CG control, is fully automatic.

Selectable quantity, single-point pressure refueling is accomplished through a refuel/defuel adapter port ahead of the right wing. The stand-alone refuel/defuel panel in the cockpit

10.3 psid, providing a 4,500-ft. cabin at FL 450 and a 5,680-ft. cabin at FL 510.

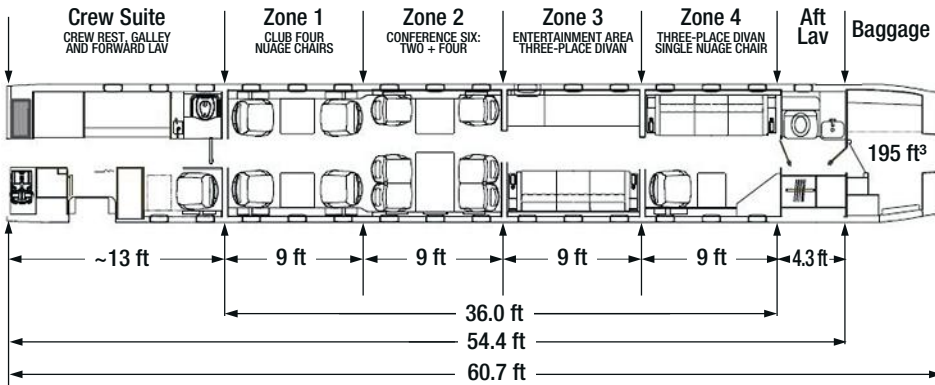
Notably, cabin air is partially recirculated through a HEPA filter normally in flight. But the crew can select 100% fresh air with no loss of fuel efficiency in cruise and no loss of range performance, according to the flight planning and cruise control manual. The recirculation function, though, improves cabin heat-up and cool-down performance on the ground after the APU is started.

Electrical heating provides anti-ice protection for the air data “smart” probes, total air temperature probes, ice accretion sensors, angle of attack (AOA) vanes, and windshields and cockpit side windows, plus the EVS camera window and fairing.

Smoke detection and fire suppression are strong points. There are smoke detectors in the forward avionics cabinet behind the copilot, the forward and aft lavatories, cabin closets, crew rest area, below-deck avionics bay, and baggage compartment. There are fire and/or overheat sensors in the main landing gear wheel wells, engine nacelles and APU enclosure. Two halon bottles provide

fire extinguishing for the engines, APU and now also the aft baggage compartment. Along with the usual cockpit indicators and controls, there also is a remote aft baggage fire extinguisher activation switch in the aft lavatory that first must be armed in the cockpit.

Global 7500 Standard Cabin Layout



The Global 7500's four-section cabin can be configured 10,000 different ways. And no layout encroaches on the crew rest area.

has been replaced by a virtual refuel panel on an avionics fuel system synoptic page.

Fourth-, seventh- and 10th-stage bleed air is used for cabin pressurization and air-conditioning, wing leading edge and engine cowl anti-ice heating, and fuel tank inerting. Seventh-



The galley is the largest in a purpose-built business aircraft; forward club section has optional 23-in. wide Nuage lounge chairs; entertainment suite is upgraded with larger video monitor and forward, padded bulkhead.

stage bleed air is used exclusively for cowl anti-ice. Fourth- and 10th-stage bleed air, pre-cooled by heat exchangers inside the cowls, is routed into the aft fuselage for the other functions. Left and right air cycle machines (ACMs) refrigerate and dehumidify bleed air for cabin air-conditioning and pressurization. Hot bleed air is mixed with cold air from the ACMs to regulate temperature in four zones, one more zone than in older Globals. Bleed air is also used for engine starting, supplied by the APU, a ground cart or cross-side engine. The APU can pressurize the cabin up to 14,000 ft. on takeoff, providing the option for engine bleeds-off takeoffs for enhanced hot-and-high airport performance. Pressurization differential remains unchanged at

All external and internal lights aboard the aircraft are long-life LEDs. The landing lights incorporate a pulse function, tail logo lights are standard and several entryway lights welcome aboard passengers at night. Service lights, on 20-min. timers to conserve main aircraft battery life, illuminate the nose and main landing gear wells, areas under the engine pylons, the baggage bay and aft equipment bay. Emergency lights are provided for the 48-lb., right over-wing, Type III emergency exit and pathway to the wing trailing edge and entry door.

The aircraft has an initial 17,000-cycle “design service goal” or economic life. After that milestone, more intense scheduled maintenance will extend its useful life. Basic

inspection intervals are 850 hr. or 36 months. Major maintenance C-checks are slated for 12 years or 8,500 cycles.

Unprecedented Cabin Comfort

We spent more than 2 hr. in the cabin of the Global 7500, riding from Wichita to Portland, Oregon, enabling us to explore it in detail. Our first impression when entering the cabin was its bright ambient lighted interior, making it appear even larger than its 2,637-cu.-ft. volume and 375.8-sq.-ft. floor area suggest. Twenty-eight, 300-sq.-in. gently curving cabin windows flood the cabin with 80% more light than in older Globals. They provide more light per square foot of floor area than in virtually any other large-cabin business aircraft, accounting for the perception of exceptional spaciousness. Each window has an electrically actuated internal accordion shade with both translucent and opaque curtains. Shade control is provided by a switch at each window, a central control panel in the galley, a bulkhead-mounted touchscreen in the club suite and by means of PED and tablet touchscreen apps.

Our physical measurements of the cabin were spot on with Bombardier's claims — overall cabin width, 8.0 ft.; 6.9-ft. floor width; height, 6.2 ft.; and 36-ft. length in the four-zone main seating section, plus 54.4 ft. overall cabin length.

Bombardier quotes a delivered empty weight of 59,879 lb. for the baseline model in its May 2018 Schedule A Aircraft & Customer Support Description. There is an additional 1,821-lb. allowance for fluids, documents, galley and cabin supplies, life vests and a four-person crew, bringing BOW up to 61,700 lb.

The aircraft's standard equipment list is impressive, including a Honeywell Jetwave 15 Mbps Ka-band satcom, voice and FANS over Iridium satcom, Lufthansa Technik Nice cabin management and IFE, six external videocams, plus two media centers with hard disc AVOD storage and Blu-ray Disc players, 24-in. HD screen in the club suite, 32-in. monitor atop the credenza in the entertainment suite, along with HDMI ports

same as in the latest luxury automobiles. When not needed, they retract back into the side ledges. The foldout worktables extend flush with the side ledges to provide continuous flat surfaces from the sidewalls to the aisle-side edges.

The cabin features multicolor, variable intensity LED up-wash and downwash lighting that can be automatically programmed to provide boarding, morning, midday and evening hues to help travelers adjust their body clocks when flying through multiple time zones. Reading and table lights are designed to illuminate publications and work surfaces while avoiding glare. The overhead panels have no air gaspers, a concession to noise reduction and weight savings.

Serial number 70006 is loaded with myriad options. But loaded doesn't mean larded. BOW only went up by 179 lb. That's a tribute to the "fully fanatic" weight control regimen on "the no compromise design" imposed by Stephen McCullough, Bombardier's vice president of product development. Bombardier elects to build most of the interior kit to control weight and quality.

The Global 7500 debuts Bombardier's new "Nuage" chairs, inspired by top-end, zero gravity lounge chairs. They feature deep recline movement that pivots the rear of the seat cushion down as the back reclines. The headrest also pivots up to elevate the head in the reclined position. The chairs seemingly float on their bases as they're moved fore or aft and pivoted.

Zone 2 of the demonstrator is equipped with a novel "zig-zag" six-seat conference grouping that has 2 + 1 aft-facing seats on the forward side and 2 + 1 forward-facing seats on the aft side. A detachable leaf fills in the gap between the two tables to create a wall-to-wall 8.0-ft.-span by 2.5-ft.-wide table. The aisle-side twin seats track inboard to provide equal arm room for each of the six chairs.

Zone 3, configured as the entertainment suite aboard the demonstrator, has an optional 40-in. IFE screen in place of the standard 32-in. flat-panel unit, atop the credenza. Each of the three seats in the divan has upright, recline and berth posi-



Aft master suite in Zone 4 has optional 48-in. side full-size bed that tilts on its side for access to storage compartments; conference suite in Zone 2 has 1 x 2 forward and 2 x 1 aft chairs. Diagonal leaf table insert creates 8.0-ft. span by 2.5-ft. wide wall-to-wall surface.

in the club and entertainment suites, front and rear wireless access points and an 18 speaker audio system, among many other items.

There are plenty of features to keep passengers entertained, informed and in touch with folks on the ground. But we found ourselves spending most of the time peering out the large windows, appreciating the spectacular landscape of the Western U.S. When we did have to phone ahead to advise the family of our ETA Portland, we used our mobile phone's Wi-Fi calling feature and the standard Ka-band satcom system. Voice quality was as good as any time we've used it with cell sites on the ground.

Touch-dial controllers, featuring top-surface active-matrix OLED mini-displays, are flush-mounted in the side ledges at each chair. When pressed, they pop up to control IFE, lighting and window shades with touch and turn motions, much the

tions. There is plenty of storage room underneath the divan.

Zone 4, the master suite on this aircraft, has a 48-in.-wide full-size bed on the left side in place of the standard three-place divan. It tilts up toward the sidewall to reveal several storage compartments, handy for spare linens, towels, galley supplies or personal belongings. The aft bulkhead has a 32-in. monitor in place of the standard 24-in. unit. On the right side, there is a forward credenza dresser and an aft wardrobe close.

The "en suite" attached lavatory has its own window, wash basin and storage closet, plus stone veneer flooring. A door in the lavatory provides full-time, inflight access to the baggage compartment. While there are no restrictions to entry, it's not the largest in class, having a 195-cu.-ft. capacity. The optional aluminum step ladder is a must, as the baggage bay door sill height is 7 ft.

The forward crew suite is one of the best designed, highest functionality and most comfortable compartments we've yet seen on a purpose-built business jet. This starts with the best cockpit jump seat in class. It's well-padded, has armrests and the seating position is comfortable when it's in its sideways-facing stowed position. It glides sideways into the center cockpit where it can be pivoted to face forward for an observer or swung 180 deg. to face aft to serve as an extra crew seat in the crew rest area.

Anticipating future changes in FAR Part 135 rules, McCullough designed in a rooftop escape hatch above the cockpit, complete with foldout step in the slim forward avionics cabinet behind the copilot and 13.7-ft.-long escape strap allowing crewmembers to lower themselves to the ground.

The right-side galley is about 9 ft. long, the forward end has three chilled food/beverage storage compartments, plus a dry pantry on top. Next there's a stack with crystal storage cabinet, microwave/convection oven, steam/convection oven and stowage drawer. The main counter top is about 5.5 ft. long, but pullout extensions create a useful, U-shaped enlarged work surface.

Above the counter, there is additional crystal storage with inserts, a galley equipment control panel, paper towel holder

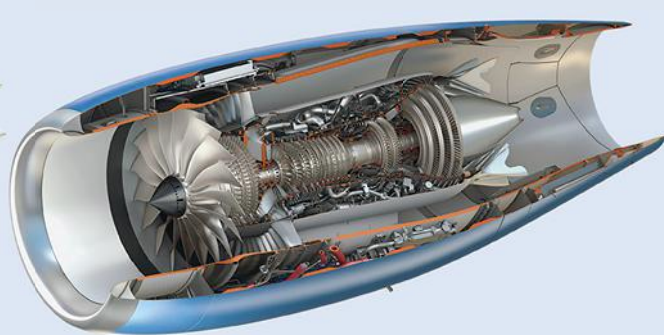
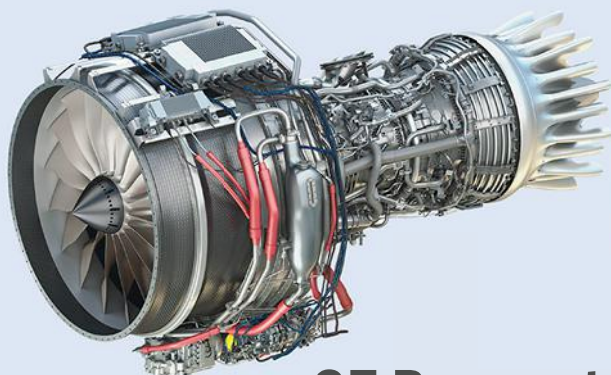
and storage cabinet. The counter has a sink with hot and cold running water, supplied by a standard 32-gal. tank. Atop the counter, there is a single coffeemaker compartment, but a second unit is available as an option. Below the counter, there are drawers for beverage cans, wine and water bottles, ice, flatware, china and coffee service items, plus dirty dish and waste storage.

Over the left-side crew rest area and forward crew closet, there is additional storage for paper goods, table linens and dry stores.

Aft of the galley, there is a forward lavatory with a window and sink, and the standard configuration includes a sideways-facing toilet. The demonstrator has a diagonally positioned toilet that offers easier access.

Bombardier has been challenged in the past to suppress cabin noise to levels competitive with models from Dassault and Gulfstream while keeping empty aircraft weight in check. The firm claims that the Global 7500 will be as quiet as current production Global 6000 aircraft. One buyer's representative measured 51 to 52 dB mean 1-kHz, 2-kHz and 4-kHz speech interference levels (SIL3) in Zones 1, 2 and 3, and 48 dB SIL3 in the Zone 4 aft stateroom.

Bombardier declined to provide its own cabin sound



GE Passport Makes Debut

The 18,920 lb. of thrust produced by General Electric's Passport 20-19BB1A capitalizes on the multi-millions of dollars the company invested in the CFM Leap-1 engine family developed for commercial jetliners. GE claims that the Passport offers 8% better specific fuel consumption than competitive business jet engines.

The Passport borrows heavily from the low- and high-pressure sections of the -1B powering the Boeing 737 MAX, having a single blisk fan and three-stage low-pressure compressor powered by a four-stage low-pressure turbine — one fewer stage than any jetliner version. The lower pressure compressor is fitted with variable bleed valves to optimize airflow and to shed ice crystals into the bypass duct to prevent high-pressure compressor FOD.

The 52-in. fan provides a 5.6:1 bypass ratio, about half that of the engine's jetliner versions. Aft of the lower pressure section, there is a deep-fluted mixer nozzle inside the long, lean nacelle to reduce noise and improve high-altitude thrust.

The high-pressure section has a 10-stage compressor,

ultra-low emissions combustor and two-stage high-pressure turbine. The first four HP stages feature fuel pressure actuated, variable stator vanes, a technology GE has been using since the 1950s to prevent compressor stall and improve acceleration. Both the high- and low-pressure turbines feature active clearance control to reduce tip leak losses.

The accessory gear box hosts fuel, oil and hydraulic pumps; a single 60-kVA variable frequency AC generator; permanent magnet generator for emergency power to the FBW system; permanent magnet alternator to power the FADEC; air turbine starter; and N2 speed sensor. The FADEC provides thrust management, thrust reverser control and envelope protection, including during start, automatic rotor bow motoring and compressor bleed valve scheduling.

The left and right engines are identical, allowing them to be swapped side to side. The gull-wing cowl doors open exceptionally wide for ease of maintenance access. An onboard oil replenishment system enables the crew to remotely top off the engine oil tank as needed from a reservoir in the aft equipment bay. **BCA**

measurements. While we could not crosscheck the sound measurements of the buyer's agent during our demo ride, in our opinion many customers may want to consider the 345-lb., option 2580-0001 enhanced soundproofing package to reduce interior sound below baseline levels.

Flying Observations

We strapped into the jump seat of s.n. 70006 after having flown the engineering simulator to experience FBW direct law mode, engine failure on takeoff and crosswind landing behavior.

Senior Engineering Test Pilot Maurice "Moe" Girard belted into the left seat and Senior Demo Pilot Bruce Duggan strapped into the right. With three of us in the cockpit, zero fuel weight was 61,679 lb. Fuel load was 16,300 lb., resulting in a 77,979-lb. ramp weight. With that much Jet-A, we could have flown 2,200 nm, landing with 200-nm NBAA reserves.

Based on using slats/flaps 3, takeoff speeds were 108 KIAS for V_1 and rotation, 122 KIAS for V_2 and 167 KIAS for V_{ENR} flaps up. With a -7C OAT, winds 060 at 7 kt. and 1,333-ft. field elevation, takeoff field length was 3,319 ft. on Runway 1L. Pitch trim would be manually set at 7.4 units, based on CG, takeoff weight and slats/flaps configuration.

Switching on the main and APU batteries, the crew checked voltages and signaled for ground power to be connected. We were immediately impressed with Bombardier's clear and consistent use of EFIS colors — magenta for computer-generated targets; cyan for pilot-selected data; green for active or short-range nav; white for standby, information and scales; yellow for cross-side; amber for alert; and red for warning. The Vision cockpit is a model of ideal ergonomic design, in our opinion.

In little more time than it takes to read "fire switches guarded; hydraulic systems, nosewheel steering and engine switches off; fire detection system OK; warning lights checked; and nav lights on," we were ready to start the APU. Its FADEC automates the process.

Pre-start checks are short and straightforward. The electronic checklist senses switch positions and systems status, so there's no need to check off many items that are configured correctly. Basically, it boils down to annunciators dark, knobs at 12 o'clock and switches forward. Then, switch on the red beacons and move on to start.

Engine run switches then are turned on one at a time. The AC boost pumps automatically activate, APU bleed air is routed from the packs to the air turbine starters and the FADECs handle the other chores. N2 core idle rpm was about 68.2%, N1 fan speed stabilized at 22% and fuel flow was 500 lb. per engine.

It took a noticeable nudge on the throttles to start the aircraft rolling. Out of the chocks, idle thrust is all that's required to keep the aircraft rolling.

With start complete, the crew shut down the APU, checked the FBW system as it was the first flight of the day, checked anti-ice systems, checked the flight controls and turned on the nosewheel steering. The weather was cold and overcast. Engine cowl anti-ice must be used if OAT is at or below 10C/50F with visible moisture. Wing anti-ice must be used during takeoff at temperatures below 5C/41F.

Pressing the takeoff/go-around button sets the initial target pitch attitude at 17.5 deg. and V_2+10 as the target speed. If engine failure occurs at or below V_1 , those targets, respectively, are reduced to 13 deg. and V_2 automatically.

During the long taxi from Bombardier's ramp to the departure end of Runway 1L, residual idle thrust slowly increased taxi speed. Girard occasionally had to deploy one thrust reverser to keep it in check.

Directed to line up and wait, the crew checked autobrakes set for rejected takeoff (RTO), potentially providing 8 ft./sec² deceleration up to 70 kt. and as much as 50 ft./sec² maximum deceleration at higher speeds. They did a final check of V speeds, takeoff trim, CAS messages and landing lights, as we taxied into position.

Once cleared for takeoff, Girard held the brakes, the crew pushed up the power levers until the autothrottles engaged, checked engine instruments and released the brakes. N1 fan speed was 93.1% and fuel flow stabilized at 6,240 lb./hr. per engine. At a takeoff weight of 77,750 lb. and with 37,840 lb. of thrust, takeoff acceleration was sporty. Girard rotated just after the aircraft reached the first taxiway.

He called for gear up with a positive rate of climb and slats/flaps 1 passing through 1,800 ft. Slats and flaps were retracted at 200 KIAS and 2,800 ft. We settled into a 250 KIAS climb at 5,000 ft. and continued at that speed until 10,000 ft. Above 10,000 ft., the crew used a 300 KIAS/Mach 0.85 climb schedule to FL 470. We noted that the autopilot chases climb speed somewhat, causing a little occasional bobbing in pitch attitude.

We experienced a short level-off at FL 360 as ATC kept us clear of higher traffic. Once cleared to continue, the aircraft reached FL 470 15 min. after takeoff in ISA to ISA-5C conditions, burning 2,100 lb. of fuel in the process.

At a weight of 75,600 lb., the aircraft cruised at Mach 0.85, equivalent to 484 KTAS in ISA-3C conditions while burning 1,280 to 1,370 lb./hr. per engine at 97.1% to 97.5% N1. The variation in fuel flow and fan speed was caused by upper atmosphere disturbance, but on average, fuel flows we recorded were very close to book values for the weight, temperature and 33% MAC CG.

Girard then commenced a wind-up turn to check Mach buffet boundary. At Mach 0.84, the peak maneuvering speed, the aircraft was buffet free up to 55 deg. angle of bank and 1.8 G.

We then descended to FL 430 for a cruise performance check at Mach 0.90. At a weight of 75,000 lb. and in ISA-1C conditions, speed stabilized using 92.7% N1 thrust and 1,730 lb./hr. per engine to achieve a 515 KTAS cruise speed, virtually the same as book predictions.

Down at FL 390, we pressed up to the aircraft's 0.925 MMO redline. In ISA-3C conditions and at a weight of 74,900 lb., the aircraft stabilized at 523 KTAS while burning 2,400 lb./hr. per engine, again very close to book values.

Descending to 15,000 ft. for some basic airwork, Girard fully extended speed brakes to hasten the altitude change. There was very light airframe buffeting associated with the drag devices and virtually no pitch change associated with extending or retracting them because of compensation by the FBW control system.

Extending the gear and slats/flaps 4 at a weight of 73,400 lb., Girard and Duggan bugged VREF at 114 KIAS. To check high AOA behavior, Girard disengaged the autothrottle and began a 1 kt./sec. deceleration.

The FBW system provides several high AOA protection features. First, nose-up pitch trim is inhibited below a computed minimum trim speed (VMIN TRIM). The autothrottles automatically engage at VMIN TRIM and the engine ignitors are activated. Girard had to increase pitch attitude sharply to keep the aircraft decelerating.

Next, if the spoilers had been extended, they would have automatically retracted as AOA increased. Then, maximum commanded roll rate progressively was limited. An aural "Speed" alert sounded as AOA further increased as Girard reached the soft stop of aft sidestick travel (VAOA SOFT). At that point, too, the stall-warning sidestick shaker was

triggered. As Girard pulled back all the way to the hard stop, the aircraft reached VAOA HARD. The aircraft didn't aerodynamically stall at VAOA HARD, but the FBW system limited max AOA to preserve controllability.

With the engines producing maximum available thrust, nose attitude reached 30 deg. up. The aircraft mushed over with Girard continuing to hold full aft sidestick at 83 KIAS with no apparent loss of composure.

Higher risk maneuvers were undertaken in Bombardier's engineering simulator in Wichita, essentially a Level D-quality box without a motion base. We began and ended the exercise at Memphis, approximate elevation 300 ft. The instructor favored us with day VMC conditions, 20C OAT, calm winds and all systems normal. At a programmed weight of 78,000 lb. and using slats/flaps, the FMS computed 108 KIAS for V₁ and VR, 119 for V₂ and a 3,660-ft. takeoff field length.

During the session, we "flew" the aircraft in direct law to evaluate its aerodynamic stability and control characteristics. While it's fully controllable in direct law, lacking the shaping, damping and smoothing algorithms of normal law, it's not a comfortable ride for passengers.

After a few maneuvers and landing the aircraft, we next experienced engine failure on takeoff. As the instructor failed the right engine shortly after liftoff, there were considerable yawing and rolling moments. A large-scale rudder input was needed to return the aircraft to balanced flight. Pedal forces, though, were quite pleasant. Once the slip/skid indicator was centered, the FBW system compensated for the roll moment and the aircraft was easy to control. Rudder trim zeroed out pedal force due to thrust asymmetry.

After completing the memory items and OEI checklist, we turned downwind and we were told to expect a crosswind, OEI landing. Notably, the Global 7500 is one of the few general aviation aircraft to have an OEI autothrottle feature. That offloads much of the workload during this stressful scenario. The instructor suggested a 15-kt. crosswind into the dead engine to add a challenge. We asked for 25. The sim instructor obliged.

The HUD made easy work of stabilizing the approach. We held the crab until the flare and then kicked it out to align the nose with the runway. Lacking a motion base, it was difficult to determine precise control inputs on visual cues alone to touch down smoothly. Autobrakes set to medium brought the simulated aircraft to a stop on centerline. Lack of motion notwithstanding, the exercise was valuable.

Back on board 70006, Girard and Duggan headed home to Wichita. There was ample air traffic in the terminal area. The aircraft's optional ADS-B In function enabled us to keep track of intruders as the crew positioned the aircraft for the RNAV (GPS) Runway 1L approach.

Using slats/flaps 4 at a landing weight of 72,500 lb., VREF was 113 KIAS. Total fuel burn for the 1 hr., 35-min. flight was 5,450 lb.

New Heavyweight Title Holder... for Now

The Global 7500 proves that it deserves *Aviation Week & Space Technology's* 2019 Grand Laureate for Business Aviation by offering best-in-class range, runway performance, ride comfort and passenger accommodations. Its sprightly airport

performance enables it to depart London City and fly to Rio de Janeiro, Capetown or Singapore. Due to its flexible wing structure, relatively high wing loading and fly-by-wire flight controls, it rides through turbulence with a level of comfort unsurpassed by anything from Bordeaux or Savannah.

We've not flown in a large-cabin business aircraft that has brighter ambient light flooding in from the cabin windows. The standard equipment list is unmatched in this class of business aircraft. Many items, such as Ka-band satcom and Wi-Fi, external camera array and audiovisual-on-demand entertainment system, are extra cost options on competitors.

Bombardier markets the aircraft as having a four-zone cabin. There's actually a fifth zone, one upfront that's reserved for the four-person crew. Two pilot chairs, a comfortable jump seat and the fully reclining chair in the crew rest compartment provide room to move about, stretch and sleep. The optional upper and lower crew bunk beds could prove attractive for operators who routinely fly 14- to 16-hr. missions.

This superstar of the skies cruises most efficiently at Mach 0.85 and it can fly 200 nm farther than any current-production, purpose-built business aircraft at that speed. Fuel consumption increases steeply above Mach 0.88 and range drops by more than 21% at Mach 0.90. However, when cruising at up to 500 KTAS, few other purpose-built business jets can match its range.

With all of the Global 7500's class-leading qualities, Gulfstream and Dassault are likely to answer the challenge. "They're not going to cede the top of the market," says Rolland Vincent, a well-known consultant and business aircraft market analyst. "This is going to be a three-way horse race."

By mid-2019, Vincent expects Dassault to announce an ultra-long-range Falcon

9X, a stretched, re-winged and re-engined version of the Falcon 6X with 30+ kt.-higher long-range cruise speeds and range well in excess of 7,500 nm. By year-end, he believes Gulfstream will unveil a G750-like jet with a stretched fuselage and at least 8,000-nm range. Higher-thrust variants of the Rolls-Royce BR700 Pearl turbofans are among the candidate engines.

Meanwhile, Bombardier is keeping a low profile about potential plans to create an even longer range variant of the Global 7500. Another 8,000 lb. of fuel would boost its range by more than 1,000 nm. We'd call it the Global 8500, if we were Montreal.

A new standard for top-line business jets clearly is emerging. Customers are craving nonstop access between any two cities on any two continents. Current-generation, three-zone cabin aircraft with token crew rest areas may be acceptable for 12- to 14-hr. trips between the Americas and Europe, or Europe and East Asia. But as commerce, business and personal opportunities develop in Africa, Oceania and Northern Asia, a need is developing for larger and even longer-range business aircraft, ones that rival the range of the latest long-range jetliners.

The Global 7500, Bombardier's bellwether business jet, meets that challenge and as such has a brilliant future. **BCA**

Editor's Note: Next month Contributing Editor Ross Detwiler will reminisce about his experiences with the "old" Globals. Don't miss it.



Forward crew suite has left side crew rest compartment with lay-flat reclining berth, two large windows, IFE equipment and noise insulating curtain.

A NextGen Primer

GPS positioning represents a quantum leap in air traffic control

BY ROSS DETWILER rossdetwiler.com

A “primer” is a small book for teaching children to read or a small introductory book on a subject. After interviewing people in the electronics and satellite business, I realized that a primer was pretty much what I needed to understand their world. I don’t think I’m alone.

A lot of the information contained herein on radar systems and NextGen, the FAA’s multifaceted, multibillion-dollar upgrade of the national airspace and air traffic control (ATC) system, came from an interview with Dan Schwinn, president and CEO of Avidyne Corp. in Melbourne, Florida. Schwinn is a graduate of the Massachusetts Institute of Technology and in addition to having run multibillion-dollar

was only employed around larger airports or military bases for approach assistance. However, horrific inflight collisions, over Brooklyn, New York and the Grand Canyon, in the 1950s convinced the public and federal government of the need for better en route control of aircraft as well.

While radar could provide a means for that en route traffic control, it had its drawbacks. For example, it could be difficult to identify individual airplanes if one blanked out another’s radar return. Atmospheric conditions could weaken the radar’s interrogation signal as well as the reflected return. Altitude separation still required close attention, and a good memory by the controller was key

era. Mode A transponders were four-digit code transmitters that sent out a signal when interrogated by radar. That signal was displayed on the controller’s screen in different line formats depending on the “squawk” code the controller told the pilot to enter. That helped identify individual aircraft.

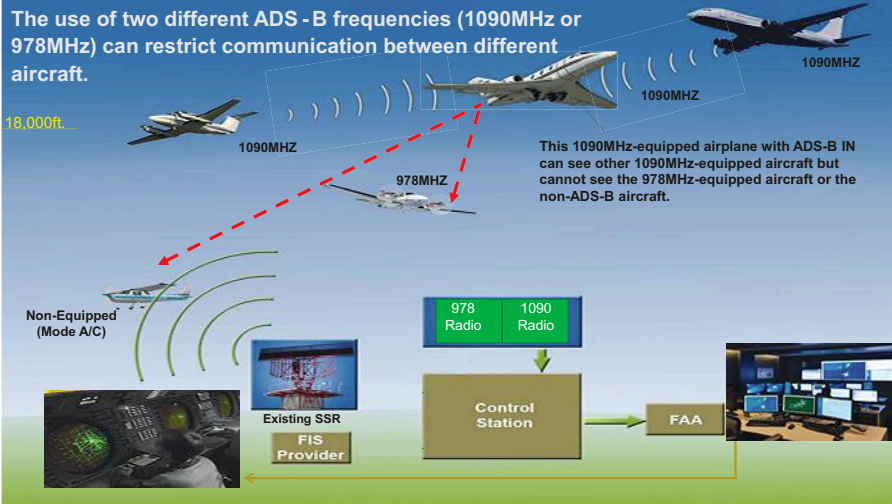
But early transponders had many of the same problems as primary radars: A radar interrogation could activate two transponders simultaneously if they were aligned; one transponder could be completely blanked out by another aircraft; side lobes of energy could activate a transponder when the antenna wasn’t pointed at it, creating false targets; multiple radars could activate a given transponder at different times, etc. Extremely capable electrical engineers worked out those flaws eventually, but it took some doing.

Altitude information was finally added as we moved to Mode C transponders. This data package was referred to as a “squitter.” Altitude readout was a great advancement, but it was linked to the aircraft’s static pressure system and would transmit any of its erroneous information.

The Global Positioning System (GPS) constellation of satellites more accurately determined an airplane’s position than had been possible with previous technology, even with sophisticated inertial navigation units. And the FAA correctly figured that GPS’s altitude, speed and direction information could provide much better data for ATC than could radar systems.

Digressing a little — after World War II the “best” method of safely landing airplanes in weather was the precision approach radar, or PAR. What person my age doesn’t remember Jimmy Stewart in the movie “Strategic Air Command” hearing “on course, on glidepath,” as he was trying to find Kadena Air Base in Okinawa fog after a 14-hr. flight from the U.S. in a B-47.

When it came time to adapt a system that the post-war airlines could use for approaches, this successful method seemed the way to proceed. However, some genius



global communications companies, he used to fly a TBM 850 and now operates a Cessna 206 and Lake Renegade amphibian in his “spare” time. His goal at Avidyne is to bring sophisticated electronic instrumentation to general aviation aircraft. My partner and I have three Avidyne units in the Beech Baron we share. Along with Schwinn, Tom Harper, Avidyne’s marketing director, contributed to my education for this article.

Our post-World War II ATC system started with radar illuminating primary targets. At the beginning, the technology

to distinguishing one blip from another. Failing that, it was “Turn left to 30 deg.” for positive identification.

Along came transponders and the secondary surveillance radar (SSR) versus primary radar. When I started flying jets in the Air Force in the 1960s, military transponders had three modes: Mode 1 was for a unit designation, Mode 2 for identification as friend or foe and Mode 3 for ATC. Civilian transponders at the time were called Mode A, thus the commonly seen reference to Mode 3/A as a description for ATC transponders of that

foresaw that if large numbers of aircraft were ever going to shoot weather approaches to individual airports, they had to be able to do that with electronic signals received directly by the airplane instruments rather than filtered through the brains of the pilot and then acted on to adjust instruments. That one concept eventually led to those signals being received by an autopilot and automatically acted upon. Thus was created the coupled ILS, according much lower and eventually zero ceiling and visibility approach minimums.

This same type of genius foresight has brought us to broadcasting of GPS-derived information for traffic control. Advanced thinking at its best.

GPS works through a series of medium earth orbiting (MEO) satellites at an altitude of roughly 12,500 mi. In other words, they are at an altitude that can complete an orbit of the Earth in roughly 12 hr. That was important in the updating of the information of the satellite position as we'll see shortly.

John "Jack" Taylor, a former senior systems engineer for Boeing, has been "flying" GPS satellites since their beginning. Although the least nerdy guy you could meet (his T-shirt reads, "Yes, dear, as a matter of fact, I am a rocket scientist"), when I spoke with him it quickly became obvious I was going to have to dumb him down a bit to get any information that would be useful to me. I once tried to read his thesis on the changes in position calculations of GPS satellites due to perturbations in their orbit. That didn't go well. He may cringe at my understanding of what he said, but my purpose is provide a "primer" of how the system works.

A GPS receiver in our aircraft measures the time it takes for a signal from one of the satellites to reach it. Given the known position of the satellite (keep reading), and assuming our receiver clock is perfect (it isn't), that time multiplied by the speed of light and gives a distance from the satellite to the receiver. This distance is the radius of a globe centered on the satellite with our airplane somewhere on the surface of that globe. A second satellite does the same and you have two intersecting globes with a huge area that represents where the receiver may be. A third satellite is needed to give us a position. With the signal from a fourth satellite, the aircraft's GPS system can determine altitude as well.

How do the satellites know where they are? Through a Master Control Station in Colorado Springs operated by the U.S. Air Force, each satellite, once a day, is fed a program providing its precise location at that time, the exact time, and, through

a few lifetimes' worth of orbital dynamic calculations, where it will be in its sphere around the Earth, each second of the next roughly 24 hr. Additionally, it is told when and where it will send out which codes precisely over roughly the next 24 hr.

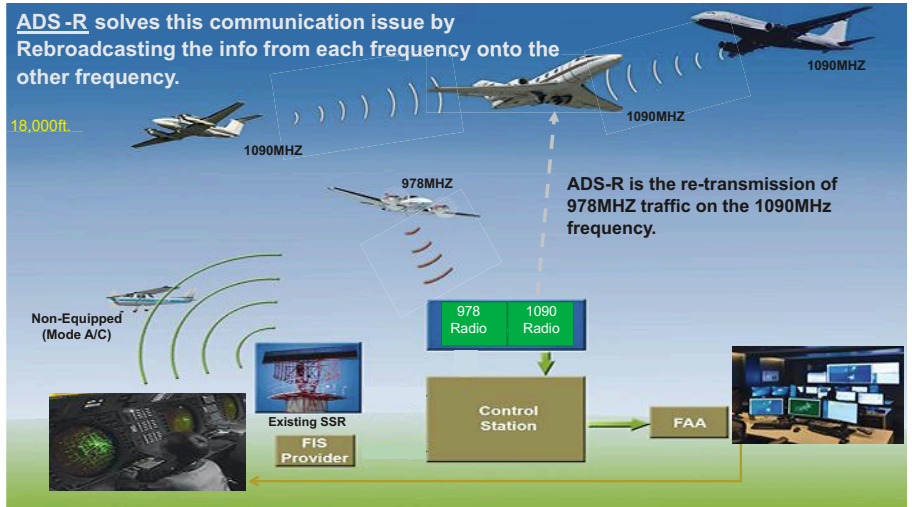
Listening to Jack, there were a lot of X's and O's and a lot of calculus involved to line up codes, but think of it this way: The satellite is told at what time it will be where. All that is needed from it is a signal telling the precise time of transmission. The receiver then has the satellite position and the time it received that signal. The difference in time calculates the length of the radius of the globe.

The satellites are not all updated at the same time or at the same place. Through the Control Station, they can be updated anywhere on the Earth at any time. That means that the constellation has an even spacing of just-updated and long-ago-updated satellites. At any given time you have extremely accurate satellites and some whose predicted positions may be up to 23 hr. into their cycle.

Remember the old days, when heading out over the ocean, you had to tune to Fort Collins, Colorado, and listen to the countdown of the "Coordinated Univer-

uploaded from the Master Control Station, the density of atmosphere at different levels and disturbances of the transmission's speed due to atmospheric ionic effects. (A recent *Aviation Week & Space Technology* article reports newer GPS 3 satellites can correct for ionosphere effects.) For ground receivers, tectonic plate shifts can affect the time for the signal to be received compared to what's expected, as can the melting of the ice pack, etc. But regardless of all these accuracy problems, the major concern of the engineers running the system is the integrity of the clock times. Without the times being kept synched and exact, all the other factors only add to possible error. If a clock "burps" a second, the positions its times are used to calculate are virtually useless.

In the early days of GPS, receiver autonomous integrity monitoring (RAIM) predictions were simple. A RAIM problem usually meant there were so few satellites visible at a given time and place that reliable GPS information could not be calculated. Today, with 31 satellites in the constellation, there will almost always be a sufficient number of them available. But the continuing concern is



sal Time" clock for a time hack. That was "close enough" for oceanic crossings in the day, but in today's GPS world, a one-nanosecond (one-billionth of a second) error in computed time for a signal to get to our receiver is equal to a position error of 1 ft. The biggest factor in accuracy of a position's calculation is the integrity and synchronization of the time signals of the clocks of the various satellites.

When you're talking to guys like Jack, they'll tell you that accuracy of the transmission time is based on many things, including the accuracy of the orbital data

whether their clock signals have integrity and are they being received with sufficient accuracy?

RAIM operates without the assistance of signals external to the GPS system (autonomous). If we have three satellites telling us what our position is, but that position doesn't jibe with a fourth received satellite's inputs, we have a problem. Is the fourth satellite correct? If so, which of the original received signals was incorrect? Was one of them incorrect or two of them? You can see this math leading to five satellites being determinant.

To isolate and exclude a fault, at least six measurements are required. Often even more measurements are needed depending on the satellite geometry. Typically there are seven to 12 satellites in view.

Newer systems have a feature called FDE or Fault Detection and Exclusion whereby the satellite determined to be in error is excluded from the equation and put down for maintenance or tested again at a different position with a different constellation dynamic.

WAAS Up With That?

As a satellite nears the end of its 24-hr. update cycle, errors can be introduced into its position calculation. The Wide Area Augmentation System (WAAS) is a system of ground stations that are all digitally interconnected, their precise geographical positions are known, and they are continually monitoring where the GPS satellites are telling them they “are.”

Since they know precisely where they are located, the WAAS stations can determine how far off the GPS broadcast positions are for each satellite in view. So, if satellite 22 is generating an error of 3 ft. north, 2 ft. west and 1 ft. down, this

slant range between aircraft divided by the rate of closure or range rate. This concept used time versus distance to issue warnings.” It was the cornerstone of traffic collision avoidance systems (TCAS).

Mode A transponders could only provide basic traffic advisories as they had no ability to tell altitude. Mode C transponders (position and altitude) provided enough information for TCAS systems to compute range, bearing and relative altitude but could be susceptible to errors due to poor pitot static systems. Older TCAS systems need to be updated in order to receive the more accurate air-to-air automatic dependent surveillance-broadcast (ADS-B) information that includes precise GPS position versus range azimuth computations.

With the advent of Mode S (select) transponders, a signal was not needed to interrogate the beacon. Mode S transponders continuously send out signals and, with “extended squitter,” can more accurately transmit many more track parameters, and even aircraft IDs, than earlier models.

Mode S transponders transmit on 1090 MHz and receive on 1030 MHz when dealing with ATC radar. All cur-

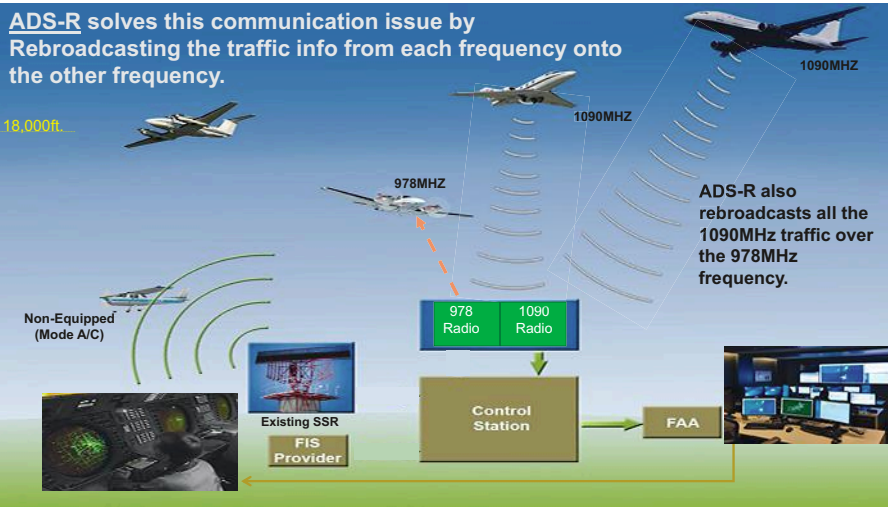
and sophisticated algorithms to provide the pilot with a Traffic Advisory (TA — “Traffic Traffic”) when a nearby aircraft poses a potential threat, and a Resolution Advisory (RA — “Traffic — Pull Up, Pull Up” or “Traffic — Descend, Descend”) when a collision is imminent and the pilot must perform a vertical maneuver in order to avoid the collision. The RAs were toned down with later models to avoid aircraft zooming into the altitude of airplanes above them.

Then came TCAS II Version 7.0, which issued different RAs to conflicting aircraft to gain separation even quicker. With this came more sophisticated “Monitor Vertical Speed” and “Level Off” commands being given to the pilot. After a midair collision between a Tupolev Tu-154 jetliner and a Boeing 757 freighter over Germany in 2008, later TCAS II 7.1 systems incorporated changes in commands given to resolve conflicts if one of the participating parties didn’t respond or responded incorrectly.

TCAS II systems have been mandated on air transport category aircraft since the late 1980s and are also installed on most high-end business aircraft. TCAS I systems, which provide TAs but no vertical RAs, represented a lower-cost alternative for light jets and turboprops. TIS (Traffic Information Service) and its limitations were an effort to at least provide traffic services to more airplanes in high-density traffic areas. By the late 1990s, the lower-cost and lighter-weight air-to-air TAS (Traffic Advisory Systems) were being developed and installed on many general aviation aircraft, providing additional safety benefits for a larger number of aircraft in the general aviation fleet. Keep in mind that the more general aviation aircraft that can “see” us, the safer the ATC system. But these TAS computers were still cost-prohibitive to many general aviation aircraft operators.

While horizontal RAs (TCAS III) have been considered twice in the last 20 years, they are not likely to be offered soon due to bandwidth problems with the amount of information needed to be sent to resolve track computation problems, even using the GPS information. Other problems can exist when a horizontal RA is followed that leads to another RA on a different airplane or when minimum local altitudes are not part of the equation.

NextGen will integrate all general aviation airplanes with, at a minimum, Traffic Information Service — Broadcast (TIS-B). Remember, all traffic operating above 18,000 ft. in the U.S. and all altitudes elsewhere gets TCAS services through 1090 MHz. If you’re going to add



error is transmitted through the WAAS system up to geosynchronous earth orbiting (GEO) satellites and then down to WAAS-enabled user sets. WAAS has made the GPS accurate enough for ILS type approaches.

Separating the Players Through Satellite Positioning

An older FAA Advisory Circular states that “Dr. John S. Morrell of Bendix came up with the concept of Tau, which is the

rent TCAS systems, in addition to their Mode S transponder, have a TCAS transceiver that, like ground radar stations, transmits on 1030 MHz and receives on 1090 MHz from individual airplanes.

TCAS today is associated with airborne transponders that, to varying degrees of sophistication, interrogate other aircraft transponders in a given area. Current Traffic Information Services (TIS), which are being phased out, work by rebroadcast of radar traffic in a specific area.

TCAS II systems use all these inputs

some 150,000-200,000 airplanes into the mix, the information highway (1030 and 1090 MHz) is going to get pretty crowded as they send and receive from ground stations as well as multiple interrogations of other airplanes to determine track, closure rate, slant range, etc.

General aviation airplanes in the U.S., that stay below 18,000 ft., will be operating the Universal Access Transceiver (UAT) on 978 MHz. In order to get general aviation users on board with the cost of installing ADS-B Out systems in their airplanes, the feds promised that general aviation could have UAT 978 ADS-B In signals from these stations (read weather and traffic information) for free. If you have a UAT (transceiver) that sends out ADS-B on 978 MHz, you still need to have a Mode C transponder as a minimum backup to make sure you're visible to all.

So, what if a general aviation operator, complying with the Jan. 1, 2020, equipping mandate for ADS-B Out, merely upgrades his current Mode C transponder and couples it to GPS WAAS position transmissions? Those GPS positions are fed down to some 700-800 currently operating transceivers that have over the last few years been erected around the U.S. These very small tower stations are so much less complex than a radar installation that they've been put on oil rigs in the Gulf of Mexico, allowing GPS routes to be assigned and seen by ATC. These transceivers take all the information that they receive on 1090 MHz as well as 978 MHz, then integrate and re-transmit it on 978 MHz and 1090 MHz to all ADS-B In receivers in the area. This is called ADS-R, with the last letter representing "rebroadcast."

How Does It Work for Us 'Bug Smashers?'

Currently, if an aircraft is equipped with just an ADS-B In hand-held receiver, and there is no 978 UAT retransmission station in the area, the aircraft will see only its position and that of 978 UAT-equipped ADS-B air-to-air transceivers. If the aircraft has no ADS-B Out, but happens to be in the area when a 978 UAT station is "tripped" by that airborne 978 transceiver, the operator will see, through the 978 UAT transmission, all aircraft within that airplane's 30-mi. "hockey puck" that goes 3,500 ft. above and below that airplane. Finally, if the airplane has ADS-B Out installed and is in range of a retransmission station, the operator will see all traffic in its own 30-mi. radius, 3,500 ft. above and below. This information

becomes valuable to corporate and airline airplanes because they are no longer the only ones aware of potential conflicts in the area. All of us will be able to see all the traffic around us through the use of ADS-B.

With more and more ground transceiver stations and more and more aircraft ADS-B equipped, we will have a system in which all the airplanes are reporting their GPS position and many with Mode S are also reporting their ground speed, track, heading, call sign and more through extended squitters.

Eventually, one potential path for conflict resolution is to use all the information that's already available through ADS-B Out transmissions and feed that into either an onboard or on-ground collision avoidance computer. The marked decrease this would generate in airborne TCAS queries would allow the system to formulate resolutions taking into account traffic that is much farther out. Perhaps, one day, even the information that is in the FMSs of a conflicting aircraft will be considered in RAs. The hope is by cutting down on the back and forth transmissions through the use of data already being transmitted, eventually a TCAS-type system will become available to all. Reso-

that it was like talking on the intercom to one of the folks in the back.

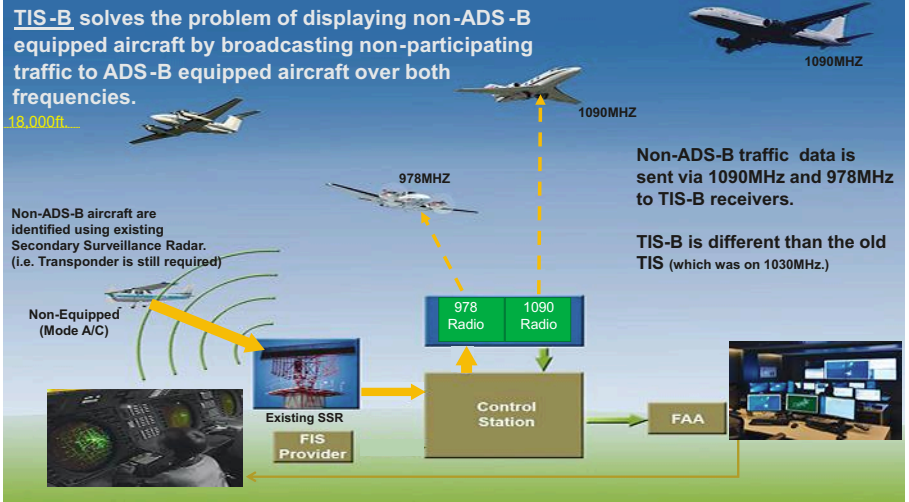
Now with CPDLC this type of position reporting can be made at much smaller intervals, automatically or with the touch of a button, lowering North Atlantic Track and traffic separation. The current system is almost a radar (or should I say NextGen transmitted GPS) environment, lacking only the picture.

To Review

The forgoing provided the background and history of the ATC system, how radar came into being and how the earliest collision avoidance systems were developed.

This article hopefully served as a good review of the basics of how GPS satellites are used to determine position and how that position is re-transmitted from our aircraft through ADS-B Out and received by the NextGen ATC system.

Those received positions are what's to be used for control in NextGen and they're re-transmitted back to airplanes via ADS-B In for collision avoidance along with weather information. Additionally, that position information is fine-tuned through WAAS, enabling to fly precise approaches using the GPS.



lutions being made farther out will lead to much smaller deviations from planned.

Finally, current controller-pilot data-link communications (CPDLC) systems using ADS-C (for "contract") transmissions are generating far more accurate and timely position information in non-radar environments.

I remember flying a leg from Honolulu to Sydney about 15 yr. ago and noting on the Pacific Oceanic charts that position reports could be made to San Francisco through satellite phone calls. I marveled

Then there's the last ongoing step in applying GPS position information toward making oceanic flight occur in an almost radar-like control environment.

The use of the GPS position for control is probably the single smartest idea since radar and the ILS. This "Primer" is for pilot use as a background for understanding when newer and even more accurate applications of the basic GPS positions are adapted by ATC. They're coming and we'll be watching and analyzing them here. **BCA**



Goodwill Flights

“Charity creates a multitude of sins.” — Oscar Wilde

COMPANIES AND PILOTS OFTEN ASSUME THAT NO HARM COULD come from offering a ride in the corporate jet at a charity auction. The FARs do allow such flights, but the restrictions are quite narrow. FAR Part 91.146 is titled “Passenger-carrying flights for the benefit of a charitable, nonprofit or community event.” Among other things, the regulation requires that such a charity flight must be nonstop, begin and end at the same airport and is conducted within a 25-sm radius of that airport. And pilots and sponsors of such flights are limited to no more than four events per calendar year.

Several FAA Legal Interpretations have explained that a corporation organizing charity flights that don’t meet the criteria of Part 91.146 can violate Part 91 even if the company does not receive any money and simply directs passengers to give directly to a charity:

Your letter acknowledges that “charities and the public could look upon the company with favor for being willing to facilitate charitable giving” and concludes that “this alone should not be sufficient to be considered compensation to the company as the company is already viewed favorably in the community for its prior direct and substantial charitable giving.” However, the FAA reiterates that it maintains a long-standing policy that compensation is construed very broadly. Therefore we caution that receipt of good will through facilitation of charitable donations in some circumstances may be construed as compensation, and thus would be in violation of Part 91 operating rules.

Pilots may believe that they can provide a charitable flight under the cost-sharing provisions of Part 61.113. However, case law dictates that the pilot of a cost-sharing flight must have a common purpose with the passenger who will share expenses.

The most amazing example of this policy restriction occurred when a private pilot received a call from a neighbor in the middle of the night. The neighbor’s father was suffering a kidney failure, and needed to get to a hospital far away. There was no suggestion that the neighbor and his father believed that they were getting a commercial service when they asked for help, and the pilot only later asked for reimbursement of his expenses. However, the FAA and the NTSB felt that there could be no common purpose for taking the trip to the hospital and thus acceptance of funds for expenses was a violation. Wanting to help a sick friend did not count.

The most disturbing element of this Good Samaritan case is the phenomenal over-reaction by the FAA. The FAA issued an emergency order of revocation. The pilot appealed, and the NTSB administrative law judge reduced the sanction to a

180-day suspension. The pilot appealed again, and the NTSB reduced the sanction to a 30-day suspension.

As explanation, the NTSB stated: “In light of these circumstances and relevant precedent, we think a 30-day suspension of respondent’s airman certificate would be sufficient to vindicate the public interest in ensuring that only properly certified commercial operators perform commercial services and,



CORPORATE ANGEL NETWORK

at the same time, to impress upon respondent the necessity of compliance with regulations despite the difficult choices that strict adherence to them may occasionally entail.”

Flying for charity under Part 91 means no compensation to the pilot/operator. Tax benefits alone are not compensation according to the FAA:

Since Congress has specifically provided for the tax deductibility of some costs of charitable acts, the FAA will not treat charitable deduction of such costs, standing alone, as constituting “compensation or hire” for the purpose of enforcing [the FARs]. If taking a charitable tax deduction for transporting persons or property is coupled with any reimbursement of expenses, or other compensation of any kind, then this policy does not apply.

Even if a charity flight is in compliance with the FARs, it may not be covered under a noncommercial aviation insurance policy. In a case involving a fatal airplane crash, where fly-in attendees could pay \$10 for a 10-min. airplane ride, insurance coverage was successfully denied because the court found the fly-in to be a commercial operation not covered under the insurance policy.

You can fly for charity, if you do it right. Corporate Angel Network and a wide variety of other services that provide humanitarian air transportation comply with Part 91 simply because the pilots/operators do not receive any compensation for providing lift to those in need. Some operations have received specific exemptions from the FAA to allow some form of limited reimbursement to the pilots/operators. **BCA**



Bombardier Global 6000

Third-generation fully matures in capability

MORE THAN 315 BOMBARDIER GLOBAL 6000 LONG-RANGE JETS have entered service since the third-generation Global Express made its production debut in 2012. Operators award it high marks for its speed, comfort, reliability and product support. With 10 hr. of range at Mach 0.85, it's perfect for dashes between Shannon and Seattle, Sao Paulo and Lisbon or Buenos Aires and Boca Raton.

Other long-range, large cabin-aircraft can fly farther, but the Global 6000 is all about passenger comfort. Outside of Bombardier's new Global 7500 flagship and Gulfstream's G650, it has the largest cabin volume of any aircraft in class at 2,140 cu. ft. Typically equipped, it will carry 11 to 12 passengers with full fuel, but it's more comfortable for eight in the conventional forward club, mid-conference and aft-lounge suite configuration. Six passengers can be accommodated in lay-flat berths.

Most aircraft are configured with a forward galley, crew rest chair (not a certified crew rest compartment) and crew lavatory. There is a second lavatory at the aft of the cabin with windows that provide bright, daylight illumination. The rear internal baggage compartment is accessible through a door in the aft section of the lav.

The Global 6000 retains the flexible wing structure of the original Global Express, affording one of the most comfortable rides in rough air of any purpose-built business aircraft, especially in lieu of its 97.5 lb./sq. ft. wing loading, the highest of any aircraft in class.

Compared to its predecessor, the Global XRS, it has improved acoustical insulation and its cabin sound levels are among the lowest in the business aircraft industry. Cabin pressurization is another strong point. The 10.3 psi differential maintains a 4,500-ft. cabin altitude up to FL 450 and 5,680 ft. at FL 510, the aircraft's certified ceiling. Most operators seldom cruise above FL 470, so cabin altitude never climbs above about 5,100 ft.

Bombardier's Vision flight deck, powered by Rockwell Collins Pro Line Fusion avionics, is perhaps the biggest upgrade from the second-generation XRS to the 6000. Vision has provisions for current and future air traffic management requirements, including ADS-B OUT, RNP approaches, controller to pilot data link communications, automatic dependent surveillance and LPV approaches. SB700-34-6018 provides ADS-B OUT functionality.

The PFDs have standard synthetic vision (SVS). A Rockwell Collins LCD HGS-6000, capable of supporting both EVS and SVS background imagery, and left- and right-side Class II EFBS are optional.

For simple short-range planning purposes, operators plan on burning 4,000 lb. of fuel per hour. Operators say they can climb directly into the mid-40s where the aircraft cruises efficiently at Mach 0.83 to 0.85, 476 to 488 KTAS at ISA. On long missions, they plan 5,000 lb. for the first hour, 4,000 lb. the second hour, 3,000 lb. the third hour and then 2,500 lb. Most say they climb directly to FL 410 and cruise at Mach 0.82 to 0.83. Long-range cruise speed is Mach 0.80, but operators say there's little to be gained by slowing down 11 to 16 kt.

Runway performance is a strong point. The Global 6000, for instance, can depart a 3,400-ft. sea-level runway and fly a 2,000 nm mission. Hot-and-high performance is enhanced with slats/flaps 0 deg. and slats/flaps 6 deg. high-lift configurations. The Global 6000 can depart Mexico City's Toluca airport at ISA+25C and fly to Madrid. However, hot-and-high OEI second-segment climb performance isn't

as strong as that of some competitors when runway length is not limiting.

Systems redundancy, automation and reliability also are pluses. Bombardier has extended scheduled inspection intervals to 750 hr. for "A" checks and 30 months for "C" checks. Many out-of-phase maintenance tasks have been eliminated. Plan on about \$260/hr. per engine for midlife inspection and overhaul reserves.

All aircraft have Inmarsat and Viasat Ku-band SATCOM systems, plus LAN systems. Most also have WiFi. Most operators generally give Bombardier high marks for product support, but some say it's still not on a par with top ranked Gulfstream. But, technical support and parts availability are improving.

It took Bombardier 15 years and three generations of Globals to achieve this level of customer loyalty. That investment now has paid off handsomely. Global 6000 operators are among the most faithful in the business aircraft community.

Global 6000 now has stiff competition from the 6,500 nm-range Gulfstream G600, fuel miserly 6,200-nm range Dassault Falcon 8X and even the 6,900-nm range G650. Asking prices range from below \$30 million on 2012 models to more than \$50 million for 2018 aircraft. But the market is soft, especially considering the competitive landscape.

Bombardier hopes that many Global 6000 operators will upgrade to its fourth-generation Global 6500, due to enter service in late 2019. Trading up to Global 6500 will increase Global 6000 used aircraft inventories. For buyers willing to wait, these third-generation Globals could become some of the best buys on the resale market. **BCA**



AIRCRAFT LIGHTING INT'L

PRESENTS

*L5800 LED SYSTEM NOW WITH DIMMER
REPLACEMENT FOR THE 5800 LED'S*



SEE YOU AT MAINTENANCE CONFERENCE | May 7-9 | BOOTH 610

Bombardier CL600

Learjet 31

DC-9

Bombardier CL604

Hawker 850XP

Sabreliners

Boeing 727

Learjet 25

Learjet 36

Cessna 560XL

Cessna 525A

Cessna

S-76A

Astra SPX

Cessna 551

Pilatus PC-12

Hawker 800

Global Express

EMB 120

Falcon 2000

Falcon 900

Hawker 1000

Learjet 45

Hawker 700

Learjet 55

1125 Westwind

GV

Gulfstream 100

SAAB 340

Cessna 550

Learjet 35

Hawker 900XP

Cessna 560

Gulfstream 200

ALI-USA

FAA-PMA

ISO 9001:2015

AS9100D

Falcon 50

Bombardier CL601

G III

Cessna 750

Westwind 1124

Hawker 600

Beechcraft 400A

PMA APPROVED LED LAMPS FOR THESE AIRCRAFT

TEL: (631) 474-2254 | sales@aircraftlighting.com | WWW.AIRCRAFTLIGHTING.COM

Advertisers' Index

AERO Specialties Page 70
www.aerospecialties.com

Aircraft Lighting Page 69
www.aircraftlighting.com

Corporate Angel Network Page 5
www.corpangelnetwork.org

Dassault Page 10
www.falcon6x.com

Embraer Page 6
executive.embraer.com

Flight Safety Page 21
flightsafety.com

Global Jet Capitol Page 19
globaljetcapital.com

Gulfstream 2nd Cover

Lektro Page 71
www.lektro.com

Piper 3rd Cover
piper.com

SmartSky Networks Page 13
smartskynetworks.com

Textron 4th Cover
www.cessna.com/denali

Ultimate Jet Charters Page 33

On Duty

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

News of promotions, appointments and honors involving professionals within the business aviation community

► **Aerion**, Reno, Nevada, has announced a new board of directors as it develops the Aerion AS2 supersonic jet. **Tom Vice**, Aerion president and CEO, has been named chairman of the board. The board includes **Bryan Barrett**, chief financial officer and vice president of Keystone Group, an affiliate of Aerion and its lead investor; **Mike Sinnett**, vice president of product strategy and future airplane programs at Boeing Commercial Airplanes; **Paul Adams**, retiring chief operating officer of Precision Castparts, who became a board member in 2018; and **Ken Shaw**, vice president of supply chain for Boeing Global Services. **Cathy Rice** has joined Aerion as vice president of business management. Rice most recently retired as vice president of contract, pricing and program business operations for Northrop Grumman Aerospace Systems. **Scott Kalister** has been appointed Aerion vice president of Worldwide Support Logistics. Kalister previously served as senior vice president of Customer Support & Services for Embraer Executive Jets.

► **American Aero ATW**, Dallas, Texas, named **Angela Thurmond** general manager of the FBO at Meacham International Airport in Fort Worth. Thurmond recently served as assistant general manager.

► **Bii (British International Industries Ltd.)** West Sussex, United Kingdom, named **Cesar Pahl** and **Marco Pozzato** regional directors. **Justin Blockley** has been named commercial director. Pahl most recently served as regional sales business developer at AJW Aviation. He will concentrate sales efforts on the Latin American region, while Pozzato will focus on Europe. Most recently, Pozzato served as regional sales manager for Avtrade.

► **C&L Aviation Group**, Bangor, Maine, announced that **Gus Taylor Jr.** is the recruiting manager, a newly-created position. Taylor has more than 10 years of experience in the field.

► **Reach Airports**, Munich, Germany, named **Ginger Evans** CEO of the U.S.-based airport management joint venture between Munich Airport International and The Carlyle Group CAG Holdings. Most recently, Evans served as commissioner for the Chicago Department of Aviation.



D. URENA RASO



MARIKA BRACK



JOSE COSTAS



TORSTEN RAABE

Hydraulic Revolution!

Welcome to the new age of hydraulic service! Introducing AERO's new state-of-the-art HPU's. Featuring a digital display with advanced software interface for usability and aircraft safety, these units offer more flow, more power, and less noise – all at a competitive price!



+1 208-378-9888 | www.aerospecialties.com CE



BENJAMIN SCHEIDEL



MARK CROTTY

▶ **Comlux**, Hergiswil, Switzerland, appointed **Domingo Urena Raso** as executive president of Comlux Completion based in Indianapolis.

▶ **Duncan Aviation**, Lincoln, Nebraska, named **Andy Richards** executive vice president and chief operating officer of Duncan's facility in Battle Creek, Michigan. For the past seven years, Richards has served as vice president of modifications and completions. **Tom Burt** is retiring after 40 years with the company. **Marika Brack** has joined the company's avionics installations sales team in Lincoln. Brack joined the company 5 years ago as wellness coordinator to the Benefits & Wellness team

lead. **Jose Costas** has joined the Aircraft Sales and Acquisitions team covering EMEA and Asia Pacific regions. He previously worked at Embraer Executive Jets as a regional vice president Sales for Europe, Africa and Middle East.

▶ **Gulfstream Aerospace**, Savannah, Georgia, promoted **Colin Miller** to senior vice president of Innovation, Engineering and Flight at Gulfstream Aerospace, following the April 1 retirement of **Dan Nale**, senior vice president of Programs, Engineering and Test. Miller most recently served as vice president of Flight Operations. **Greg Collett**, who joined the company in 1998, has been promoted to senior vice president of Manufacturing and Completions, a role held by **Dennis Stulgross**, senior vice president of Operations. Most recently, Collett served as senior vice president of Program Management, Quality and Supply Chain.

▶ **LeClairRyan**, Alexandria, Virginia, named **Morgan Campbell** and **H. Paul Efstratis** co-leaders of the Products Liability and Transportation practice team. Campbell, based in Alexandria, Virginia, joined the firm in 2017. Efstratis, based in San Francisco, joined the firm in 2012.

▶ **Phillips 66 Aviation**, Houston, Texas, announced that **Dan Gallogly** has joined Phillips 66 Aviation as director of General Aviation Value Chain Optimization. Gallogly most recently served as vice president of sales and business development for EPIC Fuels.


▶ **WhiteFox**, San Luis Obispo, California, announced that **Brett Velicovich** has joined the company as strategic advisor. Velicovich previously served as an intelligence specialist for the U.S. Army. WhiteFox is a provider of drone airspace security products.

▶ **Lufthansa Technik**, Hamburg, Germany announced that **Torsten Raabe** is the new CEO of Lufthansa Technik Sofia (LTSF). And **Benjamin Scheidel** is the CEO at Lufthansa Technik Shenzhen (LTS) taking over from **Detlev Jeske**.

▶ **West Star Aviation**, East Alton, Illinois, announced that **Mark Crotty** has joined the company as program manager for Embraer at West Star's facility in East Alton. Most recently, Crotty served as director of operations for Constant Aviation's facility in Cleveland.

▶ **Universal Avionics**, Tucson, Arizona, appointed **Dror Yahav** CEO, following the retirement of **Paul DeHerrera**. Yahav joined Universal Avionics in 2001, most recently serving as vice president of commercial aviation in its aerospace division. **Don Milum** has been appointed regional sales manager for the Midwestern U.S. and will be based in Kansas City, Missouri. **BCA**

AircraftBluebook⁷
JET APPRAISALS
 Performed by Accredited Senior Appraisers



Desktop Aircraft Appraisals / On-Site Asset Verification and Logbook Review / Residual Values / Customized Analysis

877.531.1450 / jetappraisals.com

LEKTRO Since 1945
 The Ultimate Aircraft Tug



Models ranging
 15,000 to 280,000 lbs.

- Electric • Towbarless • Certified
- Universal • Easy to Use
- Simple to Maintain • Rugged

www.LEKTRO.com
 1-800-535-8767 1-503-861-2288
 sales@lektro.com

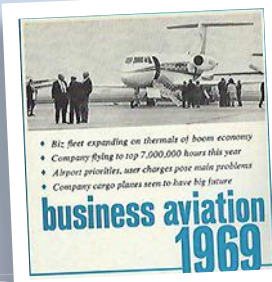
April 1969 News

Aircraft and equipment manufacturers **have banded together** in “Discover Flying,” the first industry-wide marketing/PR effort in history. **A big drop in student starts** prompted the program.

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

The demise of aircraft — the Beech Travel Air and the Cessna 320 and 411, this year — are noted along with the new entries the Aerostar and Pocono, as manufacturers struggle to meet buyer demands. The 1969 model line of business aircraft consists of some 20 pages and 175 aircraft models.

Business Aviation 1969



Business jet fleet is expanding on the thermals of a boom economy; company flying to top 7,000,000 hr. this year; airport priorities, user charges pose main problems; and company cargo planes seem to have a big future.

New to the Queen Air line this year is the Queen Air 70. This hybrid combines the Model 65 powerplants with the Queen Air 80 wings. The resulting vehicle offers more range and improved single-engine performance. Base price: \$161,500.

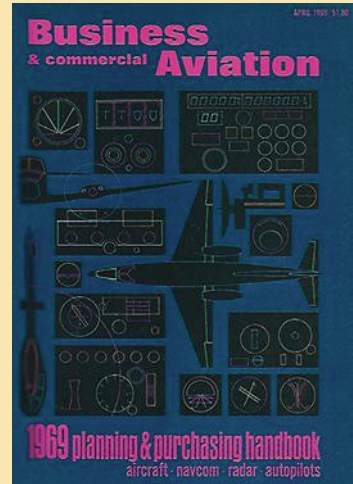
The HS 125 Series 400 has a higher gross weight (23,300 lb.), increased range payload and a combination drag reduction aesthetic clean up. Price is now \$799,900 delivered, \$1.15 million equipped.

Bell 212 Twin Jet scheduled for its maiden flight sometime this month. Bell’s sales executives plan to concentrate on the corporate-business market for the 212 and the Ranger series.

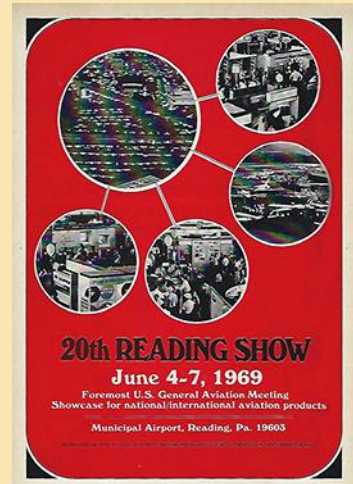
The turbine helicopter fleet, now two years old, has generated new interest in corporate executive transport use of vertiflight machines. Bell reports that 50% of its JetRanger sales last year were to corporate operators. **BCA**



THE ARCHIVE



The hardware of business aviation — 1969 — the subject of *BCA Planning & Purchasing Handbook* — includes not only the flying machines themselves, but also the ancillary navcom, autopilot and radar equipment that makes reliable, all-weather flight a reality. Readers will see familiar cockpit instruments and control heads in the renderings of artist John Nayduch.



Remember the Reading Air Show? All of those wonderful airplanes and flying exhibitions, along with the heat, humidity, rain and mud. It was a show not to be missed.

M600. MISSION: **POSSIBLE.**



1,658 NM RANGE · 2,400 LBS USEFUL LOAD · G3000 AVIONICS

Meet the powerful, pressurized cabin-class turboprop designed for your mission. Everything you need, including the lowest operating and acquisition costs in its category. An evolution of the popular Meridian, the Piper M600 is designed with a robust clean sheet wing and vastly increased fuel capacity for a smoother, more stable flight, 658 nm more range, 700 lbs more useful load and 250 kcas Vmo. Contact your dealer for a demo, or experience the Freedom of Flight™ at piper.com.

M-CLASS: M350 | M500 | M600

piper.com
1.772.299.2403

Piper[®]
FREEDOM OF FLIGHT

AMAZINGLY

SPACIOUS.

CESSNA
DENALI



THE CESSNA DENALI INTERIOR HAS MORE

- Modern jet styling
- Superior pressurization and comfort
- Larger windows and views
- Flexible configurability

Make yourself comfortable at [Cessna.com/Denali](https://www.cessna.com/denali).

U.S. +1.844.44.TXTAV | INTERNATIONAL +1.316.517.8270

