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Jet Journal

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Performance Boost for the Citation 525

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by Dianne White

Avoiding the Runaway Runway

With night IFR conditions prevailing, the light jet was cleared for the ILS approach to Runway 19. There were multiple snow showers the area, and the pilot queried the tower about the runway condition and braking action. Tower reported back that a Cessna 210 Centurion had landed a few minutes prior and reported conditions "moderate" and "fair." In fact, the Centurion pilot did not use brakes at all during his landing on the 7,000-foot grooved runway covered in a half-inch of wet snow.

The jet crew calculated the landing distance and determined they would have more than 2,500 feet of margin. They elected to continue. Following the approach and landing, the crew applied brakes aggressively, but the light jet slid off the departure end of the runway and impacted terrain. Fortunately, no one was hurt, but the plane was substantially damaged.

According to the NTSB, about one-third of all landing accidents are runway excursions, with varying degrees of severity. Worldwide, there are about two per week. While most are survivable, runway contamination is often a major or contributing factor, as illustrated in the accident above. Some are more high profile: You may recall then-Gov. Mike Pence's Boeing 737 slid off the runway at La Guardia, New York last October. Runway contamination and adverse weather conditions can quickly change a happy ending to a scary one.

Assessment Criteria		Control/Braking Assessment Criteria	
Runway Condition Description	RwyCC	Deceleration or Directional Control Observation	Pilot Reported Braking Action
• Dry	6	---	---
• Frost • Wet (Includes damp and 1/8 inch depth or less of water) ***1/8 inch (3mm) depth or less of:*** • Slush • Dry Snow • Wet Snow	5	Braking deceleration is normal for the wheel braking effort applied AND directional control is normal.	Good
-15°C and Colder outside air temperature: • Compacted Snow	4	Braking deceleration OR directional control is between Good and Medium.	Good to Medium
• Slippery When Wet (wet runway) • Dry Snow or Wet Snow (any depth) over Compacted Snow ***Greater than 1/8 inch (3 mm) depth of:*** • Dry Snow • Wet Snow ***Warmer than -15°C outside air temperature:*** • Compacted Snow	3	Braking deceleration is noticeably reduced for the wheel braking effort applied OR directional control is noticeably reduced.	Medium
Greater than 1/8 inch(3 mm) depth of: • Water • Slush	2	Braking deceleration OR directional control is between Medium and Poor.	Medium to Poor
• Ice	1	Braking deceleration is significantly reduced for the wheel braking effort applied OR directional control is significantly reduced.	Poor
• Wet Ice • Slush over Ice • Water over Compacted Snow • Dry Snow or Wet Snow over Ice	0	Braking deceleration is minimal to non-existent for the wheel braking effort applied OR directional control is uncertain.	Nil

Starting on October 1, the FAA began using a new runway condition reporting system. The FAA developed the standards with a task force that was formed after the December 2005 overrun accident at Chicago Midway Airport. In that accident, Southwest Flight 1248 ran off the end of the runway and into a city street after landing during a snowstorm. The new method requires airport operators to use the Runway Condition Assessment Matrix (RCAM) to categorize runway conditions and pilots will use it to interpret reported runway conditions.

Runway Condition Assessment Matrix

How is this new rating system manifested? As an example, a NOTAM with runway contamination reads like this:

DEN RWY 17R FICON (5/5/3) 25 PRCT 1/8 IN DRY SN, 25 PRCT 1/8 IN DRY SN, 50 PRCT 2 IN DRY SN OBSERVED AT 1601010139.

The FICON (field conditions) provides a runway condition code of 5 for the first and second thirds of the runway, and a 3 rating for the last third. If the same condition exists over the entire surface, only one code is given. The pilot would then consult the aircraft manufacturer data to determine what kind of stopping performance to expect from the specific airplane they are operating.

Pilot braking action reports will continue to be used to assess braking performance. However, the terminology "Fair" will be replaced by "Medium." Also, it will no longer be acceptable for an airport to report a NIL braking action condition. NIL conditions on any surface require the closure of that surface. These surfaces will not be opened until the airport operator is satisfied that the NIL braking condition no longer exists.

Hopefully, this simplified method of communicating runway conditions, as well as the elimination of vague terminology, will help pilots make better informed landing decisions well before the wheels touch the pavement.

Dianne

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An Active Approach t

Tamarack Aero's ATLAS Active Winglet system expands the range/payload, fuel burn and speed equation for Citation 525 line.

Citation CJ (foreground) and CJ3 equipped with Tamarack Active Winglet system.

o Better Performance

by **Dianne White**

Photos by Jet Quest

Sometimes the simplest ideas are the most effective.

Tamarack Aero has developed a product that is not only elegant in its simplicity, but delivers extraordinary results. The company has developed a winglet system for the Citation 525 family of light jets that allows it to fly farther, consume less fuel and lower operating costs without the weight and complexity penalty of traditional winglets.

And the numbers behind these improvements are nothing short of impressive: 20 percent fuel savings on a 2.5-hour trip vs. the stock airplane; 10 percent increase in range; climbs to altitude in under 25 minutes; maximum zero fuel weight increase of 400 pounds.

The small Sandpoint, Idaho company with the big idea has unleashed new potential in the most popular owner-flown, single-pilot jet — the 525, 525A, and 525B — allowing it to perform as well or better than its bigger brothers within the Cessna Citation line.

In the early 1900's William E. Somerville developed the first functional winglets, which he installed the devices on his early biplane and monoplane designs.

Winglets: Harnessing the Potential

Contrary to popular belief, winglets are not a recent invention. It has been known for more than a century that an endplate at the tip of a finite wing can reduce drag and increase wing performance. As air flows over the wing, high pressure on the wing's lower surface and the low pressure on the top surface, that creates lift. When flow around the wingtips streams out behind the airplane, a vortex is formed. Wingtip vortices, besides causing a wake turbulence hazard for trailing aircraft, creating an unavoidable consequence: induced drag. Angling the end of the wing upward increases the effective aspect ratio of the wing and change the pattern and magnitude of the vortex.

The concept of winglets as a drag reduction structure dates to 1897 when English engineer Frederick W. Lanchester patented wing end-plates as a method for controlling wingtip vortices. In the United States, Scottish-born engineer William E. Somerville developed the first functional winglets in 1910. Somerville

The Tamarack winglet is highly tuned to maximize its aerodynamic efficiency, allowing the CJ to fly farther and on less fuel. The system makes the aircraft so stable at altitude, the yaw damper inop limitation is removed.

installed the devices on his early biplane and monoplane designs. Another American engineer Vincent Burnelli received a patent for his "airfoil control means" in 1930.

While aerodynamicists and engineers tinkered with designs through the years, it took the energy crisis of the 1970s for researchers to get serious about winglet development and broad commercial application. NASA's Aircraft Energy Efficiency program studied and wind-tunnel tested a range of winglet designs with the goal of improving fuel efficiency. Aeronautical engineer Richard Whitcomb published the agency's findings in 1976, predicting that winglets deployed on transport-size aircraft could diminish drag and improve the aircraft's lift-drag ratio by 6 to 9 percent. NASA would go on to flight test a nine-foot-high winglet on a KC-135, validating Whitcomb's findings. (Fun fact: Whitcomb is the person credited for naming the wingtip device the "winglet.")

In addition to drag reduction, winglets generate lift at the tip, increasing the bending moment at the wing root and requiring the structure to be beefed up. Thus, the winglet adds weight and complexity to the wing, something the original wing designer and manufacturer could have never anticipated. Winglets on a typical airline aircraft add significant weight — as much as 1,000 pounds for a typical Boeing — and deliver modest 3 to 5 percent reductions in fuel burn. If you're an airline flying thousands of hours above FL350 on long-range flights, 3 percent can mean big savings. Traditional winglet design, however, has continued to chase the promise of 10 percent fuel burn reduction over long ranges.

Should the system lose power, the pilot will get an annunciation on the panel and will be required to slow down to a defined airspeed, similar to when flying in turbulence.

Tamarack expects to have the Citation CJ3 certified in the fourth quarter of 2017.

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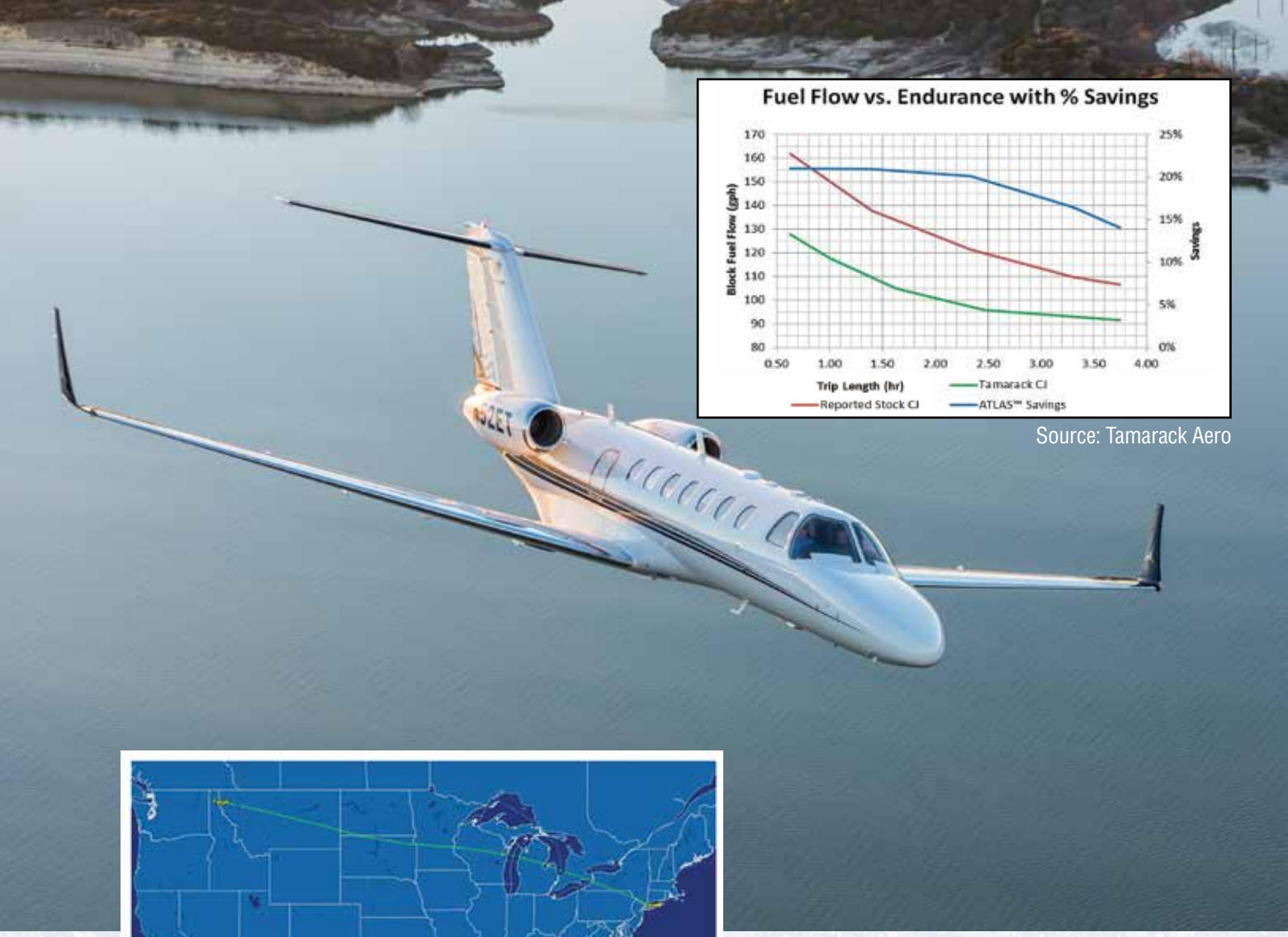


Source: Tamarack Aero

With Only a 26kt Tail Wind

Source: Tamarack Aero

Tamarack founder Nick Guida knew there had to be a better way to take advantage of the inherent benefits of winglets but without the weight and structural complexity. Guida was the kid who loved airplanes and had a natural curiosity about design and aerodynamics. As a youngster, he built his own wind tunnel to do aerodynamic testing. After getting his degree from Georgia Institute of Technology in aerospace engineering, he went to work for Boeing. After eight years, he left Boeing and accepted the chief engineering job at Aviat Aircraft, the small Wyoming company that manufactures the Husky tailwheel aircraft.

While at Aviat, Guida built an experimental plane, competed in aerobatics, and attained his Designated Engineering Representative certification for structures, loads, and fatigue. That led to a job doing contract engineering for Boundary Layer Research, which was developing aftermarket winglets for the King Air. He also worked on winglets for Hawkers and Falcons.

"All this time, I'm realizing how bad winglets are for the aircraft structurally," he said. "All this metal we are throwing at it, all these straps and reinforcements on ailerons. It seemed silly. That's when I had an epiphany: what if we could turn 'off' the winglet during higher g-force events, but still reap the aerodynamic efficiency benefits during normal 1-g phases of flight?"

That big idea was the Tamarack Active Winglet system. After proving his concept out and doing some initial testing on his own aircraft, he applied for a patent, and decided the best airframe to benefit from his new idea was the Citation 525.

"First, it's a great aircraft, and second, there are about 1,800 of them flying. Finally, the wing is the same for the 525, 525A and 525B making certification simpler," Guida said. "There are a lot of owner-pilots who fly the 525, and they are passionate about them. We are taking an aircraft they love and making it better."

Tamarack successfully certified its system with the European Aviation Safety Agency (EASA) in late 2015, and received FAA STC validation for the Cessna 525, which includes the CJ, CJ1, CJ1+ and M2, last year. The company has partnered with Textron Aviation to offer the winglet system exclusively through its network of service centers. The install price is $239,900.

How the Tamarack Winglets Work

Tamarack calls their product the ATLAS Active Winglet system, which has three components: a wing extension (five feet on the Citation 525), a "powered" or active load alleviation device and the optimized winglet. The load alleviation system — called Tamarack Active Camber Surface, or TACS — is a device extension that is installed on the outboard trailing edge or the wing. The system senses increases in G-forces, such as during turbulence or maneuvers, and automatically activate to dump the load. If you look closely during maneuvers, you can see them subtly move much like you see on any other control surface. This alleviates the structural stresses that you would normally find on a conventional or "passive" wing and winglet. However, due to their relative lightweight and simplicity, there is no weight penalty trade-off and they do not require any wing reinforcement.

The TACS is completely independent of the aircraft's flight control systems and operates autonomously. The only time the pilot needs to interact with the system is during pre-flight with a push-to-test button. Should the system lose power, the pilot will get an annunciation on the panel and will be required to slow down to a defined airspeed, similar to when flying in turbulence. With wing loading no longer a concern, the winglet itself is a highly tuned and optimized for maximum aerodynamic efficiency.

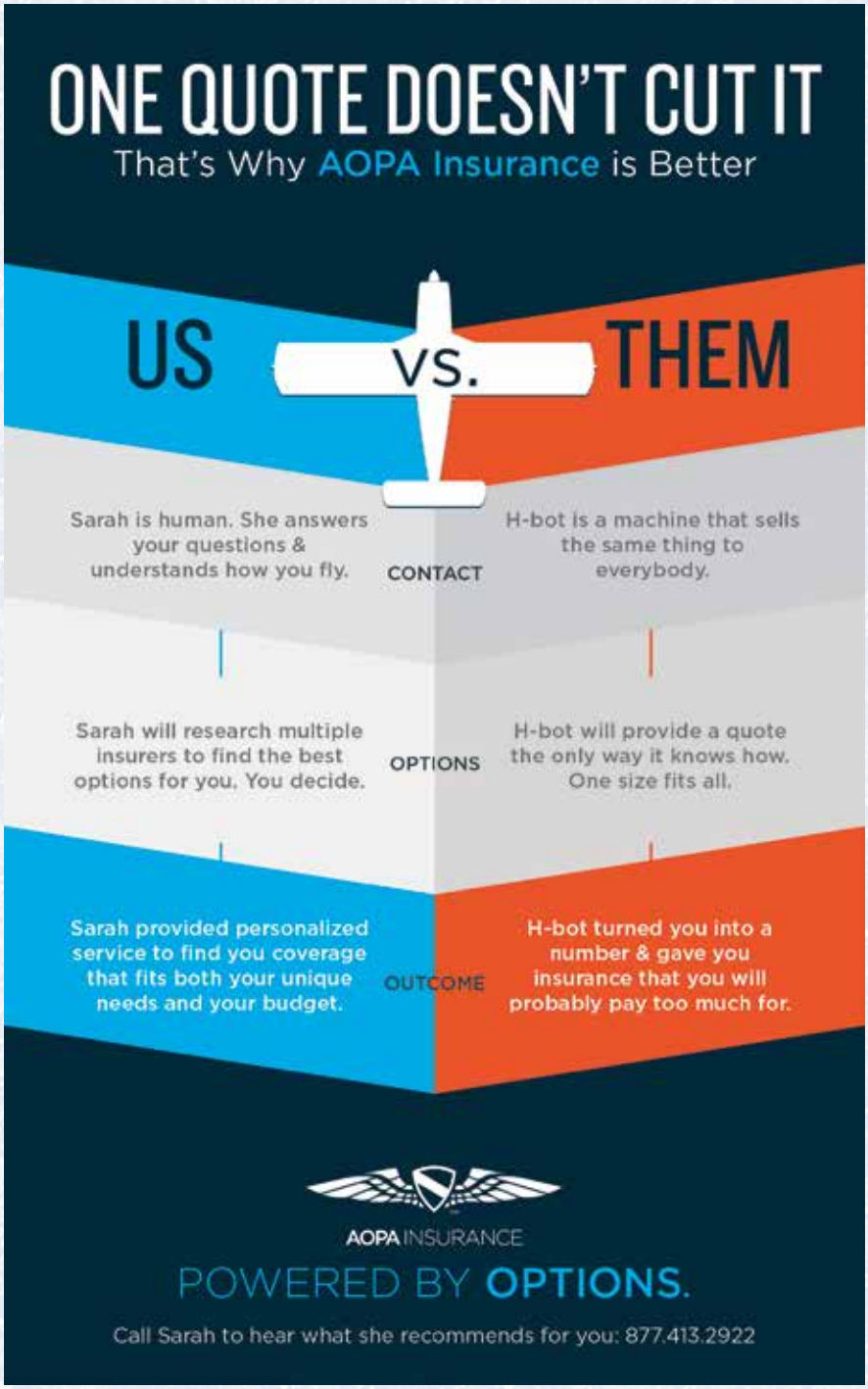
For the Citation 525 equipped with ATLAS Active Winglet system, the aircraft experiences many dramatic performance improvements. The system allows the 525 to climb quicker and get to altitude faster, shortening second segment climbs and speeds. This translates to significant fuel savings of as much as 25 percent decrease in fuel burn. On a recent CJ3 test flight from Orlando to Sandpoint, Idaho, Guida reported the Tamarack testbed saw a 10 percent increase in range (more than 200 nm)

The system also provides a maximum zero fuel weight increase — 400 pounds in the CJ3 — as well as better hot and high performance.

The winglet system increases the span and dihedral of the wing, which enhances stability at altitude and eliminates the yaw damper inop limitation. Some other benefits are that the system also improves low-speed handling, lowers stall speeds and increases the fatigue life of the wing.

Former Cessna test pilot and instructor Kirby Ortega, who has test flown the Tamarack system, said he was impressed with how the system makes a good airframe even better.

"Previously, I was never a fan of winglets, because they were never designed to deliver anything but modest improvements," he said. "When I flew the Tamarack, the fuel savings were obvious in the first 30 minutes of the flight. The climb impressive, allowing us to go directly to FL400 in less than 25 minutes."



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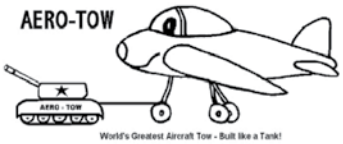

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He also saw an improvement in stability and ride. "Once at altitude, I switched off the autopilot and depressed a rudder pedal to see how quickly it would return to stable flight. It cycled back and forth perhaps four times before returning to straight and level. It's a little heavier in roll, but felt solid and comfortable to hand-fly," he added. "It makes a difference for the passengers in back, especially those who are terrified of turbulence. It dampens the turbulence and makes the ride smoother for them."

Bern Kotelko, a CJ1+ owner-pilot based near Edmonton, Alberta, first test-flew the Tamarack Winglets in while attending the Citation Jet Pilots Association annual convention and was so blown away by performance improvements, he immediately scheduled his aircraft for installation. He has been flying the system on his own aircraft for a year now, and said the decision was "a no brainer."

On the CJ1+, Kotelko said he now can climb directly to altitude with no step-climbs. Within 5 minutes of leveling off, the AOA decreases from 0.4 to 0.2. "Before the winglets was added, it would take 30 to 45 minutes for the aircraft to get on plane and pick up speed."

With his typical mission being between Edmonton and southern California, he often lands with no less than IFR reserves (650 pounds), even with headwinds. He also said the lower stall speeds adds a safety cushion on days with gusty winds or wind shear on approach and landing.

"It's the most cost-effective improvement you can make to an already great plane," he said. "I have CJ2 range performance but the cost of the winglets is 20 percent of the cost to upgrade to the CJ2."

What's Next for Tamarack

With the CJ3 system expected to be certified in the fourth quarter of 2017, the company is already working on the 525A CJ2 certification program. Guida wouldn't reveal which business jet airframes will follow the 525 series, but said the small company had some big things in store. Last fall, it was reported in *Jane's* that Tamarack was interested in working with Lockheed Martin to equip the U.S. Air Force's fleet of C-130 Hercules transports with its active winglet technology.

"My focus is to grow the company and add three more product lines. We have some military programs underway and are talking to the airlines," he said. "We have a lot of good stuff going on and expect to be going like gangbusters." T&T

The Tamarack Active Camber Surface, or TACS, is a device extension that is installed on the outboard trailing edge or the wing. When wing loading is increased, such as in turbulence or maneuvers, the TACS automatically dumps the load, which relieves structural stress to the wing.

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Cessna Citation Business Jet Celebrates 45th Anniversary

In January 1972, Cessna Aircraft Company delivered its first Citation business jet, the first ever to be designed and certified for single-pilot operations. Following the delivery of the Cessna Citation 500 to American Airlines, Cessna would go on to deliver 52 jets that year, making it the industry's biggest seller.

The publicized launch retail price at the time was $695,000, which included factory-installed avionics, ground and flight training and a one-year computerized maintenance tracking program. By the time the first Citation was delivered, Cessna had spent approximately $35 million on the project — 40 percent of the company's net assets.

Bruce Peterman, the Citation's chief engineer at the time, was quoted, "Everyone thought we were off our rocker when we came up with that plane. But we just kept producing the airplane and making it better until we wound up with the majority of the market."

Departing from the company's habit of giving its planes numerical nomenclatures, the aircraft was named "Citation" after the racehorse that won the Triple Crown in 1948. The company's marketing drew parallels between the famous thoroughbred and the business jet's performance, flexibility, handling efficiency and appearance. One of the aircraft's first fans was California Governor Ronald Reagan, who leased a Citation for official use after a rash of hijackings raised safety concerns.

Fast forward to 2017, the Citation has grown into a family of business jets, which continue to lead the light and midsize markets. More than 7,000 Citations have been delivered and the worldwide fleet has amassed nearly 35 million flight hours. Currently, there are eight Citation models in production (Mustang, M2, CJ3+, CJ4, XLS+, Latitude, Sovereign+ and Citation X+) with two under development (Longitude and Hemisphere).

"This milestone marking 45 years of industry leadership is really a celebration of the thousands of people through the years – customers and employees – who have made the Citation line of business jets the world leader," said Kriya Shortt, Textron Aviation's senior vice president, sales and marketing. T&T

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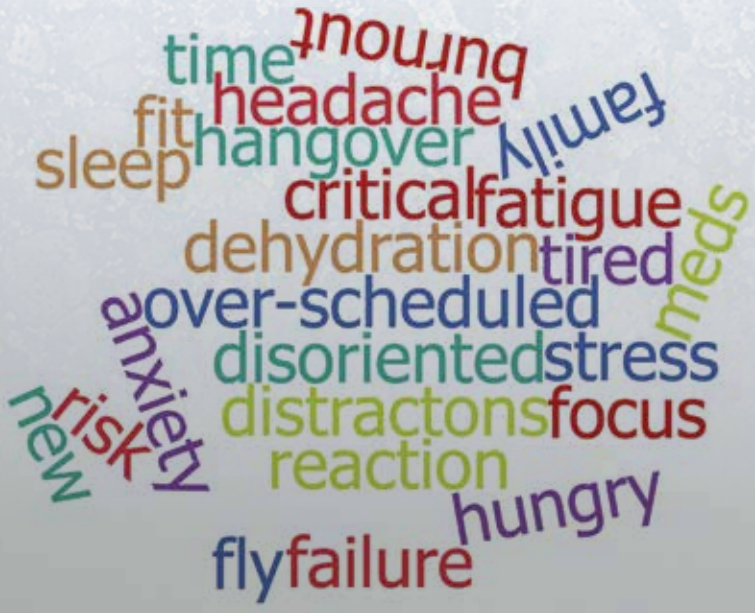
by **Kevin R. Dingman**

KBKL – 29 Dec 16 – 2250L – 26023G32KT 6SM -SN BR SCT012 BKN021 OVC026 01/M02A. The Aircraft: 2012 Citation 525C CJ4, 6 SOB. Crew: Owner-pilot. The passengers: his wife, two sons, a neighbor girl and her dad. The trip: a one day out-and-back for a basketball game. Last radar contact: 2,100 MSL (1,600 AGL) over Lake Erie, descent rate 3,750 fpm. Speed: 245 kts, accelerating. TRACON: 12.5 rpm, 4.8 seconds/sweep.

Since the aircraft did not appear on the next radar sweep five seconds later, you could postulate that radar coverage was to about 1,800 MSL or 1,200 AGL. As the aircraft accelerated to perhaps 270 to 280 kts, the final 1,200 feet of the descent below radar coverage consumed something less than one additional radar sweep, or three to four seconds.

The airplane was capable, the pilot experienced. His family was onboard; he would not knowingly push his luck. The flight home was at the end of a long day. It was a cold, windy and bumpy departure. They were most likely on top at about 3,500 for less than a minute. And something happened: to the airframe or motor(s), the avionics, the autopilot, the flight instruments, to him physically or to his situational awareness. Maybe it was something a little bit bad. Maybe it was something terribly bad. Either way, the jet got away from him.



A Critical Decision

Would you be ready for "it"? And what is "ready?" Has anyone ever officially asked you before a flight? When the answer is obvious, you know. But how do you determine where the fuzzy, judgement edge of the envelope lies?

In the Part 121 world, we're required to electronically sign our names before every flight verifying that we are healthy, rested and up to the task. It's part of the new crew rest FAR's intended to address our state of restfulness, to ensure adequate sleep and to mitigate the effects of short- and long-term fatigue. While primarily focused toward flight scheduling practices and daily changes to those schedules, it also provides a no-fault method to remove yourself from flying. In Part 91, our self-regulated, fit-to-fly determination is unmonitored, yet as critical as fuel and weather minimums.

Fit to fly is not only about sickness and fatigue. It means mentally up to speed as well. How much mental energy did you already

spend before this flight? Once-in-a-lifetime events like the loss of a friend, family member or even a pet, a jam-packed holiday season or an issue with children or grandchildren, a foreclosure, an ongoing IRS audit or a lawsuit can make it easy to recognize if we are unfit to fly because we feel bad. But it's not just during a period of unhappy, bad mental issues that causes problems. A long day of excitement, laughter and good times are tiring. In fact, a good-times exhaustion is more difficult to recognize as a threat because you feel "up" and your mental cup feels full when it's actually empty.

Once the adrenaline subsides, it will affect our ability to focus. The aerospace vehicles and the airspace system in which we operate are intricate and complicated. Mental and physical fatigue can cause us to skip a checklist item, deviate from an instrument procedure or miss radio calls. And perhaps forget to adjust an aircraft system or navigation component from one phase of flight to another. We could forget something potentially dangerous like a landing clearance, extending the flaps or even the landing gear. Flying when we are not at full strength can cause confusion, disorientation and slow reactions, especially if we are surprised by something bad, or something terribly bad. We must accurately assess our readiness to face both non-normal and emergency situations.

Quadratic Polynomial

Do you remember the mental exercises (typically writing, math and simple puzzles) used in the reduced oxygen trainer or altitude chamber to demonstrate the onset and effects of hypoxia? Alcohol, hypoxia, mental tiredness and sleep deprivation all have similar symptoms and create similar barriers to decision making. When

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When the unexpected happens at the most inconvenient phase of your flight, will you be ready?

Before contemplating your next flight, honestly assess your fitness to act as PIC.

tired or sick, checklist items, system limitations and instrument procedures can seem as difficult to perform as the seven steps in factoring a quadratic polynomial. If we are not fit to fly, could the unfitness itself cause us to misjudge the fuzzy edges of our fit-to-fly decision? Probably, yes. So here is a good old-fashioned memory mnemonic to help us methodically measure our fitness to act as PIC:

IMSAFE

I = Illness

The FAA regulates this topic by stating that if a pilot has or develops a known medical condition that would prevent him from obtaining a medical certificate, he is prohibited from flying as a required crewmember. The pilot alone is responsible for ensuring that his own health is up to par before taking the controls. From sinus pressure to a fever, a cold or flu, a persistent cough to general malaise, pilots can become more of a risk to the flight than an asset.

M = Medication

Many prescription and over-the-counter medications can be dangerous for a pilot to take before flying. We need to be aware of residual effects of both short-term and long-term use of medications. Even after the medication has been stopped, the effects may remain in the body for some time. You can Google the half-life for medications to give yourself a clue, but not an excuse.

S = Stress

A small level of stress can be good; it keeps us sharp. But stress can accumulate and affect performance. There are at least three kinds of stress that pilots should be aware of: physiological, environmental and psychological. Physiological stress is stress in the physical sense. It comes from fatigue, strenuous exercise, being out of shape or changing time zones, to name a few. Unhealthy eating habits, illness, and other physical ailments are also included in this category. Environmental stress comes from our immediate surroundings and includes things such as being too hot or too cold, inadequate oxygen levels or loud

noises. Psychological stress can be more difficult to identify. This category of stress includes anxiety, social and emotional factors and mental fatigue. Psychological stress can occur for many reasons such as divorce, family problems, financial troubles or just a change in schedule.

A = Alcohol

The rules surrounding the use of alcohol while flying are clear: FAR 91.17 prohibits the use of alcohol within the eight hours before flying, while under the influence of alcohol, or with a blood alcohol content of 0.04 percent or greater. Remember, we can follow the "Eight hours from bottle-to- throttle" rule and still not be fit to fly. Hangovers are dangerous in the cockpit with effects similar to being drunk or ill: Nausea, vomiting, extreme fatigue, dehydration, difficulty focusing, dizziness, etc. The FAA recommends that pilots wait at least 24 hours after drinking before flying.

F = Fatigue

The effects of fatigue are cumulative, meaning that small sleep deprivations over time can add up. Pilots should also consider time changes, jet lag and day/night scheduling options when managing fatigue. Both mental and physical fatigue should be assessed.

E = Eating

Should you eat just before going on a flight? How about that bowl of chili and a plate of nachos with jalapenos? You need to plan this aspect of your schedule. Eat close enough to the flight that your body is fueled but not so close that you are digesting a lot of food just before and during the flight. And think about which foods do not agree with your tummy. Especially the ones that your digestive system likes to "process" quickly, if you know what I mean.

A man's got to know his limitations.
– Harry Callahan (Clint Eastwood)

After a day of meetings, decision-making or fun and excitement, before you hop into your airplane to go home or to the next scheduled event, find somewhere that you can be alone. Where you don't have anyone to convince you of how great a pilot you are and how important, routine, easy or short the next flight will be. Have a talk with yourself that goes something like this: In the first 10 minutes of this flight, I am going to lose an engine, the autopilot and part of the NAV system. Someone in the back of the plane will be asking what the loud noise was. Am I ready for it? Can I handle a hand-flown, single-engine approach in this weather with a degraded NAV system? When the answer is no, tell your boss, the pax or your spouse that you can't fly when the weather is like this, at this time of day or when tired, burned out, headache, hungry, diarrhea, you lost a sock, broke a shoestring — whatever. Lie to them if you need to; tell them you can't factor a quadratic polynomial. But don't lie to yourself. Because something a little bit bad, or something atrocious, can happen. Maybe something you can handle. Maybe something no one could handle. Theodore Roosevelt once said, "Nine-tenths of wisdom is being wise in time."

Give yourself the time. T&T

Making History Fly

by **Rebecca Groom Jacobs**

PHOTO COURTESY OF PAUL BOWEN

"It flew like a good B-29."

Six, simple words — representing decades of tireless work.

On July 17, 2016, history was made when a fully restored B-29 named "Doc" roared back into the sky for the first time in 60 years.

First Flight

Everyone is in place by 8 a.m. Approximately 250 volunteers, supporters and media crowd the designated VIP watch area — a roped-off grassy strip by the McConnell Air Force Base runway in Wichita, Kansas.

It's flight-perfect weather, with clear skies and light winds from the south. The energy is contagious. Hugs, smiles and high fives are shared all around. A day nearly 30 years in the making has finally arrived.

A few especially popular attendees include Tony Mazzolini, Doc's rescuer, Charles Chauncey, a World War II B-29 pilot, and Connie Palacioz, a real-life Rosie the Riveter (who riveted a portion of Doc's nose over 70 years ago). Individuals who represent the large numbers of airmen, factory workers and patriots this airplane's mission is meant to honor.

"The reason I started this project is to help keep the memories alive and this national treasure visible," Mazzolini later reflected. "After you put in so many years, it's hard for me to put into words how it felt to get to first flight. But it was emotional, there is no doubt about that."

Just south of the fenced runway, more than 1,000 people of all ages have gathered, some who have traveled hours from neighboring states to witness the event. Police have barricaded the street to safely accommodate the masses. Wichitan and pilot Parker Madill is there with a group of friends.

Additional spectators include more than 65,000 viewers who have tuned in to watch Doc take flight via a live web stream. Over the years, social media has helped Doc accumulate thousands of passionate followers and fans from all over the world.

Nearby, four massive 3,600-horsepower hybrid radial engines roar to life, one at a time. The ground-shaking rumble is the product of Doc's hybrid Curtiss-Wright 3350-95W and R-3350-26WD engines.

The flight crew aboard is primarily composed of B-29 flight crewmembers from the world's only other flying B-29, FIFI, operated by the Commemorative Air Force. The crew made several trips

to Wichita to work closely with Doc's Friends restoration team leading up to this moment. Charlie Tilghman, retired Southwest Airlines captain and former Air Force pilot, is pilot-in-command.

"Anytime you are dealing with an airplane as big as a B-29, it takes lots and lots of people. It is a joint effort," explained Tilghman. "This is an airplane with no pilot amenities: no nose-wheel steering, no anti-skid brakes, no reverse, no boosted controls, no yaw damper, no autopilot. It takes a little muscle to fly ... but it's a good-flying airplane."

Cheers suddenly erupt. Doc has begun to taxi. The world is about to gain its second flying B-29 Superfortress.

B-29's Role in WWII

The Boeing B-29 Superfortress made its way to the drawing board in 1940 after a request was released from the U.S. Army Corps for a long-range heavy bomber aircraft. Tensions were rising overseas; continental Europe had fallen under Axis control and the need was becoming urgent for an aircraft that could reach Europe from the United States.

The request crossed the desk of Phil Johnson, president of the Boeing Aircraft Company. By June, Boeing approved the Model 345, and a wooden mock-up was completed by the end of the year. The urgency of production soon catapulted.

On Dec. 7, 1941, the Empire of Japan attacked Pearl Harbor, and the United Sates was violently thrown into war. Immediately, military and industry representatives hammered out a plan for B-29 production and determining Wichita would be a base for manufacturing and assembly. Incredibly, the prototype B-29 successfully flew just nine months later. At this point, 1,650 B-29s had already been ordered by the military.

Double in weight, payload and range of its predecessors, this was the most technologically advanced aircraft of its time. It was also the first pressurized warplane with automatic gun turrets (state-of-the-art innovations that ultimately made the B-29 the most expensive weapons project of World War II, surpassing even the Manhattan Project).

Flight test faced numerous issues, most notably the engines. The 2,200-horsepower Wright 3350 18-cylinder radial engine was simultaneously in development and designed to be the most powerful of its time. But incredibly, Boeing still met the military's pressing deadline and the B-29 was combat-ready.

Thousands then flew to airfields in the Mariana Islands and prepared to embark on grueling bombing missions. By the end of 1944, hundreds of aircraft departed these fields at 30- to 45-second intervals to fly missions of over 14 hours and 3,500 miles almost entirely over water.

Infamously, it was the B-29 named Enola Gay that dropped the first atomic bomb on Japan, ultimately leading to the end of the war in August 1945 and sealing the airplane's importance in history.

Doc's Story Nearly Ends on a Bombing Range

Doc's chronicle began in December 1944 when it rolled off the Boeing Wichita assembly line (Serial No. 44-69972) and was delivered to the U.S. Army Air Corps the following March. The giant bomber earned its name when it was assigned to the "Snow White" radar squadron, each of whose B-29s were names after one of the seven dwarfs.

During World War II, radar squadrons were used to train the navigator bombardiers on the latest radar equipment used for bombing and routing. Radar was exceptionally important because most of the bombings took place at night.

Over the next 11 years, Doc would serve in various noncombat roles before being retired to China Lake, California, to be used as a target for Navy missile testing and bombing practice. For 42 years, it sat in the Mojave Desert until Tony Mazzolini and a team of local volunteers were finally able to rescue the relatively unscathed warbird from its resting place in 1998.

Doc Restoration a Massive Volunteer Effort

Deplete of the necessary resources to piece the giant airplane back to operational status in California, Tony Mazzolini soon contacted Doc's birthplace, Boeing Wichita. Boeing executive at the time, Jeff Turner, welcomed the opportunity to have the World War II hero return to its home. So the rescue team in China Lake, led by Tony, disassembled Doc and shipped to Wichita on seven flatbed trailers in 2000.

"People were just thrilled to see the airplane, regardless if it came in parts or not, because it was a Wichita product ... and they knew the mission. Restore the airplane and bring it back to flight again. A lot of people wanted to be a part of that program," said Mazzolini.

For 42 years, Doc sat in the Mojave Desert until Tony Mazzolini and a team of local volunteers were finally able to rescue the warbird in 1998.

PHOTO COURTESY OF DOC'S FRIENDS.

Continued on page 22

BRETT SCHAUF PHOTO

Doc returns safely from its successful first flight July 17, 2016.

Since the day Doc arrived, thousands of aircraft parts have been donated and refurbished in kind, and more than 350,000 volunteer hours have been invested toward bringing Doc back from the brink of destruction. Local mechanics, engineers, electricians and other technicians came together from neighboring manufacturing plants — several dedicating their retirements and even their final years to the project.

But the restoration could not have been possible without the numerous manufacturers supplying custom components. Next door, Spirit AeroSystems machined one-of-a-kind parts and airframe structures in the very factory Doc was built.

"We did not just restore the airplane, we remanufactured it," said Murphy. "We literally took every piece apart, inspected it, cleaned it and put it back together. Structurally, we kept as many components as we possibly could. But all systems and glass are brand-new. The list of companies to thank is a long one."

The team was able to recover and recertify most Doc's original cockpit instruments. The instruments are back in the airplane, but not without a few modern additions. The B-29 panel is also outfitted with Garmin's GTN 650, GTX 33 and GDL 88 (all removable for show display).

In 2013, Doc's Friends was formed by Wichita business leaders to financially support and complete the final stretch of the restoration of the B-29 Superfortress. The group continues to manage events, fundraising and communication efforts meant to ensure and protect Doc's future.

Doc's Future

Currently, flights are on hold due to the low temperatures. Similar to many warbirds, it is impractical to operate Doc in winter conditions. However, in the months following first flight, the crew logged multiple flights around the Wichita area. The crew says the airplane performed beautifully and Doc will resume flight checks in the spring.

So, what are the new obstacles in Doc's future?

"The biggest upcoming challenge will be recruiting the next generation of volunteers to help maintain the airplane," Murphy said. One is to build up the flight crews, but the other is to transition the invaluable knowledge from our longtime volunteers to this new generation — which will become a lot easier once we relocate to our own hangar."

Doc's Friends is finalizing plans and fundraising for a permanent hangar space to be located at Dwight D. Eisenhower National Airport. A hangar will allow for much-needed protection from the elements and serve as a public museum where Doc's story can be told, and the memories of World War II kept alive.

Meanwhile, Back on the Runway…

At McConnell Air Force Base, Doc has rumbled out onto the runway for a second time. The first attempt was met with an issue with the bomb-bay door closure. Now with the doors securely latched, the crew readies for takeoff.

The pilot applies full brakes and instructs the flight engineer to set 30 inches of manifold pressure. The flight engineer obliges, running the power up on each engine, all while checking temperatures and pressures. He announces when everything is stabilized, and Tilghman eases off the brakes and pushes his own throttles — advancing them asymmetrically to maintain directional control based on the winds.

The airspeed comes alive at about 65 mph indicated. Tilghman then applies slight back pressure on the yoke, lightening the nose tire and allowing the airplane to accelerate until it chooses to fly off the runway, which occurs at about 105 mph indicated and 3,500 of ground roll.

"In jet airplanes, you rotate the nose at 15 degrees and go blasting off into the sky," explained Tilghman. "But in the B-29, you establish a flying attitude and

wait for it to lift off and maintain a very shallow rate of climb while the landing gear comes up and flaps retract. Then you start thinking about climbing."

The landing gear is kept down on first flight, but the modern hybrid Curtiss 3350 engines easily lift the B-29 skyward. Much lighter than its former self due to less armoring and fuel, the airplane is capable of climbing and traveling faster than it did on its previous missions more than six decades before.

On the ground, cameras are rolling and the crowd is cheering and shedding tears. For the first time since 1956, B-29 Doc is airborne.

As the thousands watch, the warbird smoothly soars to 1,000 feet and cruises around the pattern. Seven minutes later, Tilghman greases a beautiful landing and taxis, greeted by continuous, loud cheers.

The crowd is soon informed the flight was cut short due to a chip detector light. But the crew is confident the alert is likely false and a result of breaking in the new engines (which was later confirmed).

B-29 Doc's first flight is a success.

Flying Museum

Although Doc's permanent home base is Wichita, the aircraft will serve as a traveling museum and exhibition. Doc's Friends is currently negotiating 2017 tour dates and locations.

STEVE JANTZ PHOTO

The large team of Doc volunteers, many of them retired Boeing employees, took every piece apart, inspected it, cleaned it and put it back together. More than 350,000 volunteer hours have been invested toward bringing Doc back from the brink of destruction.

Help Keep Doc Flying

It still requires an army to operate and support a B-29 Superfortress. From volunteers to donors, mechanics to marketers, it is a joint effort.

To help ensure Doc's operational status throughout this year and the future, a combined team of communicators from Spirit AeroSystems and advertising agency Sullivan Higdon Sink are working diligently to share Doc's story and mission across the country. Here are ways you can help:

Donate directly – via the Doc's Friends website: *www.b-29doc.com* (Paypal) or mail (P.O. Box 771089, Wichita, KS 67277)

Purchase Doc merchandise – shirts, hats, first flight memorabilia and more are available online via Yingling Aviation's gift shop, *www.aviatorsattic.com/Doc-s-Friends*.

To stay up to date on all Doc news, subscribe online at b-29doc.com or follow Doc on Facebook (*facebook.com/docsfriends*) and Twitter (*twitter.com/docsfriends*).

ALEX UNRUH PHOTO

A few members of Doc's flight crew celebrate just prior to its successful first flight. From left, Rick Garvis (crew chief – secondary flight engineer), Glenn Mount (right scanner), Tony Mazzolini (Doc's rescuer), David Oliver (co-pilot), Don Obreiter (left scanner).

"This year, we have a lot to learn about touring and operating the airplane economically," said Murphy. "In the next few years, we will expand and start offering rides and more of a complete schedule. Certainly, one of the main events will be to fly with *FIFI*. No one since 1956 has seen two B-29's fly in formation."

The group will release tour information on its website and social media accounts once a schedule is confirmed. Soon, people around the country will be able to see Doc in person and gain a richer understanding of our aviation history.

"There were certain things that happened along the way where you say to yourself, it's like it was meant to be," said Mazzolini. T&T

Rebecca Groom Jacobs is a private pilot and Content Marketing Specialist at the Wichita office of Sullivan Higdon & Sink, a marketing and advertising agency with an aviation, aerospace and defense focus. Though raised around general aviation, she first considered it as a career while learning to fly in a Piper J-3 Cub in 2010. Coincidentally, she then spent two years at Piper Aircraft before joining SHS Wichita. SHS is a marketing and communications partner for Doc's Friends. Contact Rebecca at rebecca.jacobs@shscom.com.

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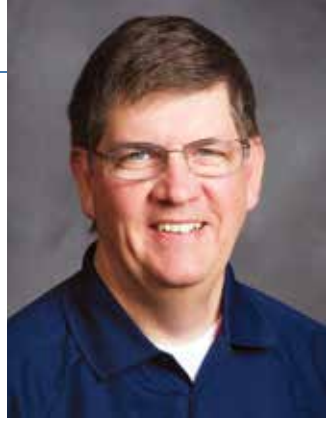


Departure Control

Focus the same amount of care and attention to a low-visibility departure as you do an instrument approach.

From an NTSB Preliminary Report:

A Cessna Citation 525 (CJ4) was destroyed in a collision with Lake Erie shortly after takeoff from runway 24R at the Burke Lakefront Airport (BKL), Cleveland, Ohio. The pilot and five passengers are missing and presumed fatal. The Part 91 personal flight was in night visual meteorological conditions on an instrument flight rules (IFR) flight plan to the Ohio State University Airport (OSU), Columbus, Ohio.

The pilot and passengers initially departed OSU about 1730 (EST) and arrived at BKL about 1800. They reportedly attended a sporting event before returning to the airport about 2230. The pilot requested his IFR clearance at 2247, followed by taxi clearance at 2251. At 2256 the pilot was holding short of the runway and ready for takeoff on Runway 24R. The controller cleared the pilot for takeoff and instructed him to turn right to a heading of 330 degrees and maintain 2,000 feet after departure. The pilot acknowledged the clearance. After takeoff the controller instructed the pilot to contact departure control; however, no further communications were received from the pilot.

ADS-B position data depicted the airplane entering a right turn shortly after crossing the runway departure threshold. The airplane became established on a magnetic course of 310 degrees at about

2257:28. During this time, the airplane reached an altitude of approximately 2925 feet MSL. About five seconds later the airplane entered a descending right turn that continued until the final data point at 2257:52, 1.83 miles northwest of BKL. The associated altitude was 775 feet MSL.

The pilot held a private pilot certificate with airplane single and multi-engine land, rotorcraft helicopter and instrument airplane category/class ratings. The pilot also held CE-510S and CE-525S type ratings. The pilot's CE-525S type rating was added Dec. 8, 2016, in the accident airplane. The pilot subsequently completed a simulator-based recurrent training course Dec. 17, 2016 (12 days before his final flight).

Another NTSB Preliminary Report:

A Beech Bonanza impacted trees and terrain during initial climb near Knoxville, Tennessee. The pilot and passenger were seriously injured. Night visual meteorological conditions prevailed for the personal flight, which departed Knoxville Downtown Island Airport (DKX), Knoxville, Tennessee, destined for Moore-Murrell Airport (MOR), Morristown, Tennessee.

The pilot arrived at DKX around 0505 (CDT) to preflight. About 0530 the pilot and his passenger boarded the airplane. The pilot started the airplane and inserted his updated (GPS) data cards. He then taxied to the run-up area for runway 8. While taxiing he listened to DKX's AWOS. The AWOS was transmitting that the ceiling was at 200 feet, "or something to that effect," which the pilot "found to be untrue" since he could "look up at the sky and see stars." This was also not compatible with his weather briefings from the night before or earlier the morning of the accident.

Once the airplane was airborne, and when the entire usable runway was behind him, the pilot raised the landing gear and checked his climb attitude and trim. This was all he could remember about the accident flight. Around 0630, the Morristown, Tennessee 911 communications center received a telephone call from the pilot reporting that he had crashed sometime after departure from DKX.

The airplane had impacted trees and vegetation at an altitude of approximately 10 feet above ground level, about 600 feet from the departure end of the runway. The airplane then impacted in an open field in a level attitude with the landing gear in the up position, and slid on its belly for another 500 feet before coming to rest. Impact with the ground was at high speed with the engine at takeoff power. Examination also revealed that the airplane was equipped with shoulder harnesses though neither the pilot nor passenger had used them.

The recorded weather at KTYS (approximately 11 nautical miles southwest of the accident site), approximately 28 minutes before the accident included calm winds, 10 miles visibility, patches of fog, few clouds at 100 feet, temperature 15 degrees C, dew point 14 degrees C, and an altimeter setting of 30.03 inches of mercury. At approximately 23 minutes after the accident KTYS reported exactly the same. Civil twilight began at 0710, with sunrise occurring 26 minutes later at 0736.

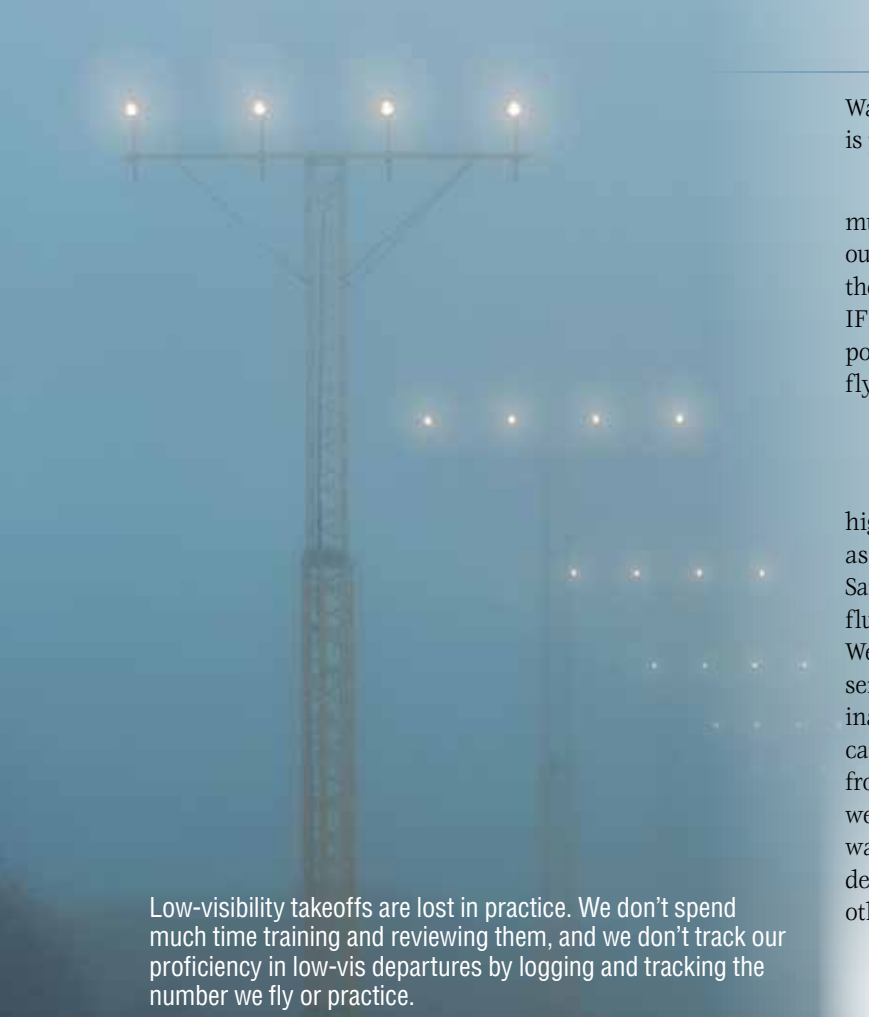
The pilot held a private pilot certificate and instrument rating. He had approximately 300 total flight hours, 190 in the accident airplane make and model.

And an NTSB Final (Probable Cause) Report:

A Beechcraft Baron 58 impacted trees and terrain in Palos Hills, Illinois. The private-rated pilot and two passengers sustained fatal injuries. Marginal night visual meteorological conditions prevailed. The flight originated about 2235 (CDT) from the Midway International Airport (MDW), Chicago, Illinois, and was en route to the Lawrence Municipal Airport, Lawrence, Kansas.

At 2228, the pilot contacted MDW controllers to obtain an instrument flight rules (IFR) clearance. The controller was not able to access the flight plan information and requested that the pilot provide him the information by radio transmission. The pilot queried the controller asking if it would be easier to take off under visual flight rules (VFR). The controller informed the pilot that if departing under VFR, he would only need the aircraft type information and the desired direction of flight. The pilot elected to provide the information and received a VFR clearance to depart MDW. During communications between the pilot and controllers, no clearance for flight in instrument conditions was authorized.

Radar data showed the airplane departed runway 22L at MDW and began climbing on runway heading (220 degrees). At 2238:01, the airplane had accelerated to a groundspeed of about 130 knots and climbed to an altitude of about 2200 ft MSL. When the airplane was about 3 nautical miles from MDW, it began



Low-visibility takeoffs are lost in practice. We don't spend much time training and reviewing them, and we don't track our proficiency in low-vis departures by logging and tracking the number we fly or practice.

accelerating and descending as it turned about 20 degrees to the left to a heading of 200 degrees, followed immediately by a turn to the right. By 2238:38, when the airplane was about 4.8 nm from MDW, the airplane had descended about 700 ft to an altitude of 1,500 ft MSL. The airplane then began climbing. As the climb was initiated, a left turn was also initiated. The left turn continued while the radius of the turn decreased until the end of the radar data. During the final left turn, the airplane initially climbed about 400 feet, descended about 400 feet, and then climbed again about 1,300 feet before reaching a peak altitude of 2,800 ft MSL at 2239:24. At this time the airplane was about 5.9 nm from MDW and about 0.1 nm from the accident site. The final radar data point was at 2239:29 at a recorded altitude of 2400 ft about 6 nm southwest of MDW. The calculated rate of descent between the final two radar points exceeded 5,000 ft per minute.

The pilot held a private pilot certificate with single-engine land, multiengine land and instrument airplane ratings. The pilot received his multi-engine rating about eight months earlier. He had 417 hours of total flight experience, including 114 hours of multiengine experience.

Lost in Practice

Instrument training and evaluation is weighted heavily toward arrival and approach procedures. We log the number and type of approaches we fly, and consider precisely flying an arrival procedure the ultimate test of our IFR ability — even if we let an autopilot do the job for us, albeit under the pilot's watchful eye. Way down on the training/evaluation priorities list, however, is practice and proficiency in flying departure procedures.

Low-visibility takeoffs are lost in practice. We don't spend much time training and reviewing them, and we don't track our proficiency in low-vis departures by logging and tracking the number we fly or practice. When called upon to make an IFR or marginal VFR night takeoff, our skills are often far less polished, and we frequently have far less recent experience in flying the procedure.

False Climb

Compounding the challenge of low-visibility and sometimes high-workload departures is a physiological hazard known as the "somatogravic" or "false climb" illusion. The Flight Safety Foundation identifies somatogravic illusion as the result of fluid moving in a pilot's inner ear when an aircraft accelerates. We sense this motion as a pitching movement upward — a false sensation of climbing. Without a good natural horizon and if inattentive to or distracted from the instruments, this sensation can cause us to want to push forward on the yoke to "recover" from the false climb. They force the airplane downward because we think it is going up too steeply or too rapidly. I suspect this was a primary factor in the Bonanza's early-morning dark IMC departure, and could have played a part in one or both of the other cited crashes.

Fatigue

In our three examples pilot fatigue is a big unknown. In both the Citation and Baron crashes, the owner-pilot flew a plane full of passengers to a sporting event in the early evening, then lost control during a late-night departure after the game. The NTSB has not published any data, but I'm betting these pilots didn't get out of bed just before the trip. More likely they spent a full day at the office before going to the airport — crashing 15 or more hours after they woke up. In the early-morning Bonanza crash, again we have no idea, but a 5 a.m. airport showtime might mean the pilot had an abbreviated sleep period the night before.

Spool-Up

Here's a conundrum: you might be tired and a little worn-out by the time you begin an instrument approach at the end of a flight, but you have plenty of time to get "into the groove" and prepared for a low-visibility arrival. You have no way of knowing for certain you're up to speed for an IMC departure, however, until you're in the air and in the clouds, fairly slow while at a high angle of attack close to the ground. There isn't any spool-up time before a low-vis takeoff to get the feel for the airplane, or to catch any missed briefing or checklist items.

A common personal minimum is to require weather to be at least circling minimums for takeoff, in part to provide a greater margin if you find yourself a little behind the airplane during this unpredictable spool-up time.

Departure Control

All three pilots had fairly low time in type. But the Citation and Baron pilots both passed check rides not too long before

the crash. The CJ4 captain passed a stringent type rating less than two weeks earlier — arguably making him more proficient than many at the time. The Bonanza pilot likely passed his instrument checkride within the last 200 hours, although there's no telling how many years had elapsed.

Regardless of a pilot's experience, here are some ways to maintain control during a low-visibility departure:

Checks and flows. Use checklists and cockpit flow checks like you were taking a type rating checkride, every time you fly. Don't take shortcuts — printed checklists and confirming visual checks are designed specifically to protect you when you are a little off your game and more likely to miss something.

Organize before you fly. Get everything set before you take off. Don't think "I'll update the FMS or program the GPS once I'm in the air." Don't take the runway for departure until all the set-up work is done.

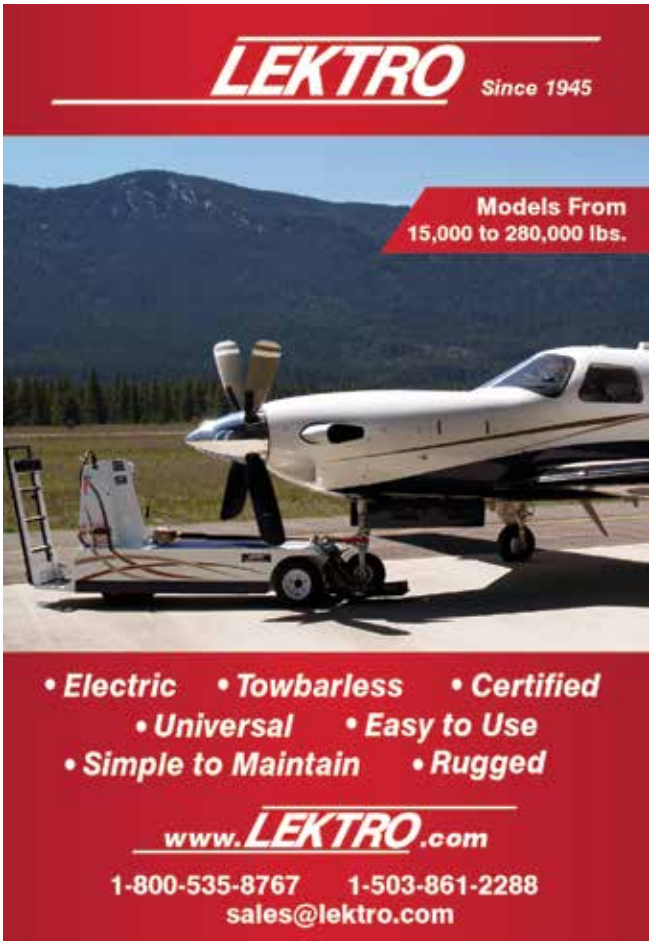
Along these same lines, resist the temptation to expedite your departure in marginal conditions, especially at night, if you're not able to get your instrument clearance right away. Not only does this put you in the air in what is likely for you an unusual and therefore stressful situation, but it almost guarantees you'll be up there for some distance and some time before you can pick up your clearance. The most common reason for a clearance delay is the presence of other IFR traffic in the area that may further delay controllers from clearing you.

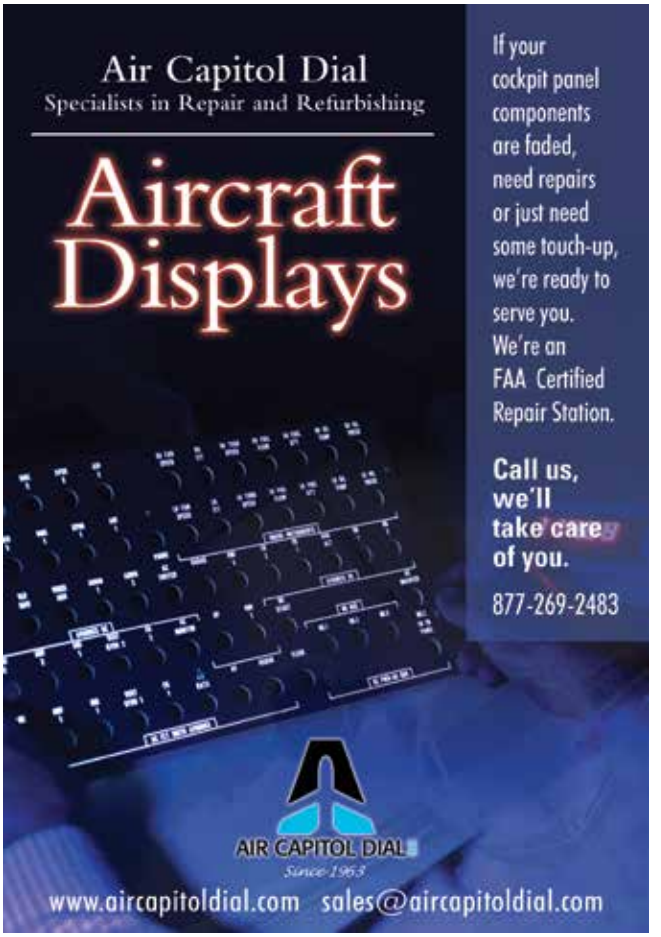
Brief the departure. Review the departure procedure and clearance with the same scrutiny you apply to an IFR approach. Brief yourself on the altitude, heading and expected route. If you're departing on vectors, know the approximate heading to your first expected fix at all times, so when you're cleared "direct to" or "own navigation" the required turn is not a surprise. If you're following a SID or an Obstacle Departure Procedure, have it loaded into your nav system and know it before you climb as well as you know an ILS before you'd descend.

Fly what you briefed. "Plan your flight and fly your plan" works. Sure, ATC may throw you a curve. But vectors or updated clearances should be the only changes you need to process mentally — be prepared for everything else.

Sterilize the cockpit. Focus solely on the immediate task at hand when making a low-visibility departure. Don't worry about rental cars or passenger relations or fiddling with radar displays until you are settled into cruise climb and well away from the airport.

We focus a lot of attention on approach and landing for good reason. But taking off into dark or soupy skies, then having a distraction of some sort, shouldn't result in a perfectly functioning aircraft impacting terrain. Plan and execute your low-visibility departures with the same care and briefing you apply to a low-minimums approach, with the added knowledge that you never know for certain how up-to-speed you are until you're already committed to flight. T&T





Off to a Good Start

While understanding a starter's "duty cycle" is critical to any piston aircraft pilot, it's twice as important when you're cranking up a twin.

by **Dale Smith**

Occasionally you just have one of those days: You're late getting away from your office. Traffic is a mess. It takes forever to file your flight plan. And to top it all off, your starboard engine just refuses to catch. You crank, and crank, and crank...all while muttering under your breath about beating that *@#$&!!* starter to death.

Honestly, a quick beat-down is a much more humane way to kill your starter than the slow and painful demise you are currently subjecting it to.

The unfortunate fact is, the vast majority of piston aircraft pilots don't really understand the significant damage we inflict on our starters through improper operations. No wonder so many of us have chronic problems with our starter's performance and reliability. And when you're flying a twin, you've just doubled your potential troubles.

So, what's a pilot to do? To get the scoop on proper operations I went directly to the source of all things starter related: Hartzell Engine Technologies, makers of the Hartzell and Sky-Tec brands of aircraft starters.

According to the company's Director of Product Support, Tim Gauntt, the main cause of most starter problems is most owners don't know how the system works, nor the stresses the starter experiences when you twist the switch.

"One area that the majority of pilots I talk to have little understanding is the importance of knowing and adhering their aircraft's starter duty cycle," he said. "Following the duty cycle guidelines will go a long way toward maximizing your starter's operational life."

What is a Duty Cycle and Why is It So Important?

Gauntt explained that the starter's duty cycle determines how well the starter can tolerate repeated starting attempts. And it includes a specified starter 'cool down' interval between each unsuccessful start.

"Not following specified duty cycle procedures will cause the starter to overheat and severely damage the unit's internal components, leading to premature starter failure," he said.

Most pilots don't understand that violating the duty cycle just a couple of times will do irreparable damage to the starter. In extreme cases, it can render the starter inoperable. Excessive cranking can also overheat the electrical supply system and cause accelerated wear to the wiring, contactor and elevated corrosion rates for the connections in the circuit.

The folks at HET feel so strongly about the importance of following proper duty cycle procedures they produced a short training video on the subject. You can see it at: *https://www.youtube.com/watch?v=uvnrbUrPy8Y*

Starter Due Diligence

As you'll learn in the informative video, every type of starter has its own particular duty cycle. And it's critically important for you to know which starter is in your airplane and how its duty cycle works. And so you don't have to take notes, here are the duty cycles for the most popular starter types as described in Hartzell's video.

Typical Duty Cycle Times for HET Sky-Tec Starters:

- 10 seconds of engagement followed by 20 seconds of rest for up to six (6) start attempts;
- After that, allow 30 minutes of cool down before beginning the next start sequence.

For comparison, here are a new starter armature and a heat-damaged armature. If the duty cycle is exceeded or the starter is not allowed to cool, the armature heat is transferred through the windings into the soldered points, which will melt and permanently damage the unit.

Typical Duty Cycle Times for HET E-Drive and X-Drive Starters:

- 10 seconds of engagement followed by 20 seconds of rest for up to 20 start attempts;
- After that, allow 10 minutes of cool down before beginning the next start sequence.

Typical Duty Cycle Times for HET PM-Series Continental Starters:

- 15 seconds of engagement followed by 30 seconds of rest for up to six (6) start attempts;
- After that, allow 30 minutes of cool down time before beginning the next start sequence.

Typical Duty Cycle Times for "Legacy" Starter Models (including the Prestolite and Electrosystems):

- 10 seconds of engagement followed by 60 seconds of rest;
- Then 10 seconds of engagement followed by 60 seconds of rest;
- Then 10 seconds of engagement followed by 15 minutes of cool down time before beginning the next start sequence.

"Following the duty cycle procedures may add a few minutes to your typical starting sequence, but understanding and following the procedures correctly will help your aircraft's starter provide you with many years of reliable service," Gauntt said.

Starting Problems Aren't Always Starter Problems

Gauntt said that a weak or slow cranking starter is one of the leading causes of people exceeding a starter's duty cycle. But, those symptoms don't always point directly at a dying starter.

"The starter is actually the last part of a sophisticated, multi-component starting *system* and problems with any of the parts, whether environmental, mechanical or operator-induced, will show up as 'starter problems,'" he said. "The health of the entire system must be well maintained to achieve consistent engine starting performance."

In addition to individual performance issues with the components mentioned below, if the engines are misadjusted or have a poorly functioning fuel system, they will also be difficult to start.

Battery: Batteries can vary in size and mounting location, either of which can influence the performance of the starting system. The efficiency of your battery can be especially critical in a twin, where the unit may be well away from the engine, requiring more cranking power.

Electrical connectors: They serve as the termination points for the electrical conductors that interconnect all the starting system's various components.

Electrical conductors: Typically, these are highly flexible, insulated copper or aluminum cables. The length and condition of each has a significant impact on the system's performance especially in a twin-engine configuration.

Switching devices: Their primary use is to control the flow of electrical power throughout the starting system.

Violating the duty cycle just a couple of times will do irreparable damage to the starter, and in extreme cases, it can render the starter inoperable.

Starter: The starter is the actual unit that converts the electrical power to mechanical energy in the form of torque, which is used to physically rotate the engine to initiate the starting process.

"No matter what the cause or reason, if any of the system's components are not working properly, the results can run from poor starter performance to outright damage to the starter itself," Gauntt said.

Starter System Troubleshooting 101

As Gauntt explained, the starter is at the end of a chain of components. In its simplified form, the starter converts the battery's electrical power to mechanical energy in the form of torque, which is used to crank the engine.

Cranking requires a significant amount of current (typically ~400A in-rush, ~70A cranking). Voltage at the battery equals the potential or *push* in the system, but if the system has too much resistance along the path, the battery can't flow enough current to the starter to do its job.

That resistance comes in the form of corroded terminals, dirty or worn contactors and old wiring. And, since they suffer from lower potential already, older aircraft with original 12-volt systems are especially prone to problems.

Also, take time to check the other components of the system to ensure good current flow including the aircraft's switches, relays, and even the aircraft's key or push-button starter device.

Age-related and moisture-induced corrosion can attack the connecting terminals and erode the internal contacts slowing the flow of power. Even the smallest bit of corrosion on a wire or connection point could be the source of a problem.

Gauntt said that a commonly overlooked point of corrosion is the engine-bonding strap. The ground system should be checked for electrical ground integrity using a VOM. A maximum of 0.2-ohms of resistance at any bonding/ground connection is the borderline limit.

While you've got the cowls off, check the condition of the electrical conductors and insulation around the wires for chafing damage. Gaps in the insulation will allow moisture to corrode the wiring, increasing its resistance.

A weak battery will make even the cleanest system struggle. Low voltage will require the starter to turn slowly and remain engaged for a longer period of time. Extended engagement periods will lead to heat build-up in the starter motor and reduce its service life.

And always, when it comes to battery troubleshooting, follow the manufacturer's guidelines for ongoing inspections, real-charge capacity testing and maintenance including checking the terminals for corrosion. Even a well-maintained battery could lose 2.5 percent of its charge in a week.

A Quick Word about Kickbacks

The dreaded kickback occurs when, during the starting process, the engine's crankshaft abruptly changes rotational direction. A significant kickback can displace the crank as much as 90 degrees in 33 milliseconds and cause significant damage to the starter's drive and gear engagement system. In extreme instances, kickback can actually break the starter's mounting pad away from the engine.

Gauntt explained that kickback issues can often be resolved by adjustments to the engine's ignition and fuel systems or through the pilot's 'modification' of engine starting techniques. Always follow the engine OEM's instructions when making changes to the system's settings or starting procedures.

(Hartzell Engine Technologies has introduced a new family of starters that eliminates kickback damage, but that's another story.)

New-Generation Starters

While the functionality of starters hasn't change in decades, Hartzell Engine Technologies (HET) and Sky-Tec currently offer an array of new-generation lightweight and legacy starters designed to deliver optimum performance even in the harshest environments.

For more information about Hartzell Engine Technologies' complete selection of starters, please visit *www.hartzell.aero* or *www.skytecair.com.* T&T

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by **Kevin R. Dingman**

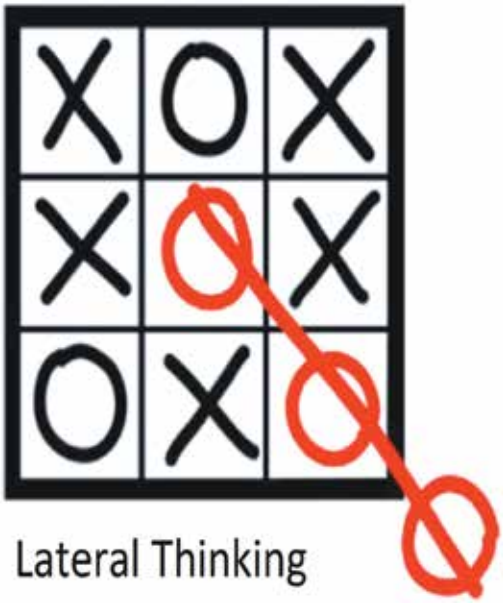
Unintended Consequences

Aviate, navigate, communicate

It was late at night; it had been a long day and you're tired. Since the airplane was ready and the wind on the ramp was gusting to more than 30 kts., you did an "abbreviated" walkaround. Anyway, the flight will take less than an hour and the weather is supposed to be decent. The departure was snowy, windy and bumpy. So bumpy in fact, that it kicked off the autopilot in the climb. When you broke out on top just a minute into the departure to the sight of the moon and stars, not to mention that the ride smoothed out rather nicely, it was proof that you had made the right decision to leave tonight. You scooch in your seat, exhale a breath and admire the moonlit clouds. This is why you fly. Tower sends you to departure control.

Climbing through 2,500 feet and headed to the northwest, departure gives you a right turn to north and a climb to 17,000. The autopilot is still off so you look out the window and start a turn and the climb. Just 100 below, the cloud deck is visible as it moves by at 200 kts, slowly dropping away. The appearance of ice that accumulated during the climb is a surprise. Surface temperature was 33 degrees F. The math was easy: the freezing level was at 1,000 AGL. Curious though, the moon makes the wing look shiny, like it's still wet. You double-check anti-ice systems and turn to your passengers: How's the temperature? Everybody warming up? Sorry about the bumps. It should be smooth the rest of the way, you tell them. They all nod in acknowledgement as they, too, admire the view of the moonlit cloud layer. A shudder surprises you because it's been smooth since exiting the clouds. No traffic, but it felt like wake turbulence. As you turn back to the front, the autopilot should have rolled out of the turn just about now. Then you remember that it's off.

Say Altitude



Why is the bank angle 45 degrees? It should be about 30 degrees. You push the yolk to the left. The ride feels like we're on a dirt road with tightly spaced waves of hard packed dirt, "chatter bumps." Like the ridges on a paved highway that announce an approaching toll booth. Why is the airplane vibrating like this? It must have something to do with the ice. You roll to the left more and pull back.

Faintly, you smell an electric train. You know that smell: ionized ozone. Electricity. Probably your imagination. The vibration gets worse; it's more like a shudder now. Scanning the motors you see the right engine is winding down. Time slows down. You instinctively push the rudder and look out the window. The inboard half of the wing isn't as shiny as the outboard half. It looks like there was clear ice on the wing itself. Back on the ramp you thought it was wet. Some of the ice on the wing must have broken loose. The beautiful cloud deck that had fallen away is approaching; it's just below you again. The yolk is almost fully to the left as you return your view to the engine gauges. Maybe the ice did something to the motor, maybe to the wing too. Two seconds later you re-enter the clouds. The moonlight is gone and it gets dark. Back on the instruments. This bank angle can't be right. How can it be 60 degrees? That must be the electrical smell: the horizon display. Where's the standby?

A calm voice in your headset says your call sign and asks you to say altitude. You push the left rudder and pull back. The airplane is shaking as the bank increases

well beyond 90 degrees, a place that you've never seen before. How could that electrical smell mess up the horizon? Maybe I'm in a spin or a stall. Nope, speed is 260 kts. Pull the throttles back. Maybe it's an accelerated stall. You hear your call sign again: Radar contact is lost, say altitude. Why can't I roll left? What's going on? The wind noise is loud as you exit the bottom of the clouds.

Just Like You

The controller repeats his call sign several more times, but no one is there to answer. The flight lasted less than five minutes. And here we sit, my friends, reading our *Twin & Turbine*. It wasn't you in that airplane. You didn't mess up. It was the other guy again. Perhaps you allowed yourself to live vicariously through this event. If so, you probably feel sick to your stomach. If not, it's because you didn't know that this is a true story. And that three months ago, the pilot from this story was reading this magazine, and this very column. Just like you. He was a good pilot, just like you.

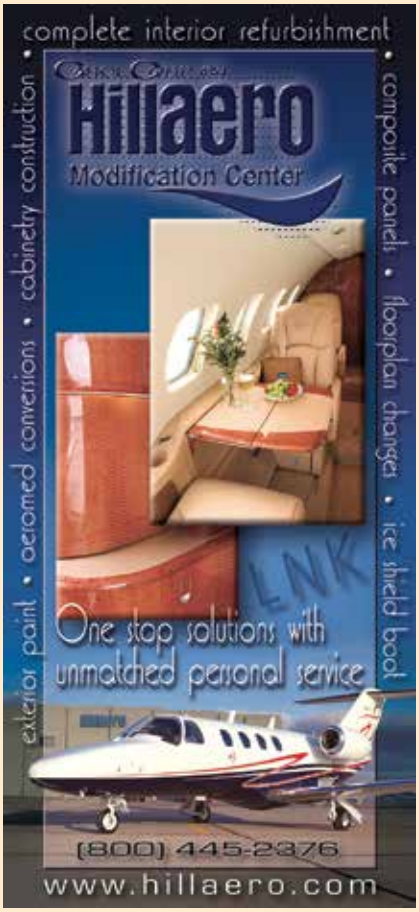
Viewing a story vicariously is how we learn and prepare. How we stay sharp. How we survive. When we remember events like this one, it makes us pay close attention. His altitude and perception of the event didn't give him enough time to sort it out. Maybe it wasn't his fault. Maybe we would have done things similar to what he did. How could anybody deal with his scenario? Is there another way to access a time-compressed or confusing scenario? First, we must be proficient and capable instrument pilots and our airplanes airworthy. After that, it's up to us to fly the airplane first, then seek solutions.

Lateral Thinking

When you understand the information presented in the operating manual — when you are proficient and one with the machine — expand your flying skills into the domain of lateral thinking. In modern vernacular, that means thinking outside the box; solving problems through an indirect and creative approach, using reasoning that is not immediately obvious. By considering ideas that may not be obtainable by using only traditional step-by-step, checklist type logic. It means not playing with the existing chess pieces, but with finding ways to change the pieces themselves.

Would lateral thinking have helped this pilot? Perhaps not. Maybe it wasn't an engine failure that our pilot faced. Maybe it was a half-inch of clear ice covering the unheated surfaces of his aircraft. Maybe he should have been deiced. Maybe the pitot static system iced over. Maybe it was an electrical fire. Maybe part of the airframe broke. Maybe it was a failure in the flight control system. Or maybe transiting several cloud layers or turning to the passengers induced vertigo. All realistic possibilities. But conventional logic, training or his proficiency were insufficient in the time allotted.

A perfectly good airplane flown by a good pilot should not crash. Besides, that clear ice thing and inducing your own vertigo wasn't a fair scenario you say? Well, to that I say you've been in too many simulators. They must give you realistic scenarios in the sim, right? And they shouldn't combine two or three bad things at once. We must be given a



fighting chance to fix things. What kind of training would it be if we crashed all the time? Well, real life isn't fair. You know that from your life on the ground, and you've seen life when it was unfair plenty of times. Why would you think it was different in the air? Who says your inflight, real-life scenarios will be fair? Who says that you will have time to sort it out? We can't train for every scenario. So we train for the ones we know about, the ones that have happened before. The ones that could happen again; the likely ones. Not the unlikely ones. Not the unfair ones. Plus, there isn't time to practice the unfair, unrealistic scenarios. There are too many. And if we are going to crash anyway, why practice them? All valid points, wouldn't you agree? Until, that is, something that has never happened, happens.

It's what you learn after you know it all that counts.

Coach John Wooden

Please take to heart my story-telling version of this catastrophic tale. It gives us a situation to live through vicariously; one to think about and from which to learn. What ever happened to the pilot in our story, I'm sure it was confusing and surreal. We need to give ourselves the best opportunity to resolve inflight problems by being physically and mentally up to speed. By pre-flighting the airplane every time and by staying proficient; by training to be ready for both the fair, and the unfair. And when our training and the published procedures fail, to think outside the box. The FAR's give us permission. In fact, they tell us to. It may provide the seconds we need. T&T

Kevin Dingman has been flying for over 40 years. He's an ATP typed in the B737 and DC9 with 22,000 hours. A retired Air Force Major, he flew the F-16 then performed as an USAF Civil Air Patrol Liaison Officer. He flies volunteer missions for the Christian organization Wings of Mercy, is employed by a major airline, and owns and operates a Beechcraft Duke. Contact Kevin at Dinger10d@gmail.com

ForeFlight Adds New Features to Latest Updates

ForeFlight released the first major update for 2017, version 8.3, which brings a collection of new features to the app. The update includes new weather maps, new night settings and logbook enhancements.

The latest addition has a new satellite weather overlay for the Maps screen that weather geeks will love. This new Color IR Satellite option in the map overlay drop-down menu. This is a second satellite layer that complements the existing satellite overlay, which is now called Enhanced Satellite.

This worldwide weather layer uses infrared images to show cloud temperatures, which typically decrease with altitude (the blue areas on the layer are the coldest). This can be useful when flying during the colder months to help identify areas that contain supercooled liquid water and possible icing conditions. This phenomenon is likely to be present in the yellow and green areas, which are just warm enough to sustain supercooled water droplets.

Night Flight

While setting up the iPad in preparation for a night flight, there are new night settings in the maps and plates section of the app. When viewing the map settings, a new option is at the top called "Invert Chart Colors." This will change any of the lighter colors on IFR en route chart or sectional to a dark color, and change black text to white, to help maintain a dark cabin and reduce eyestrain. When viewing the plates section of the app you'll see a similar option at the top left of the screen, called Invert Plate Colors. This will apply the same color shift to approach plates and airport diagrams for improved night viewing.

IFR Climb Procedures

For IFR departures, the SID procedures define required climb gradients in feet per nautical mile, and then it's up to the pilot to determine that his or her airplane can meet this performance minimum based its capabilities that day. During flight planning, we use this ft./nm requirement and planned groundspeed to determine the required climb rate in feet per minute, since that's the number we can relate to while flying.

ForeFlight can help shed more light on how the climb is progressing with a new Climb Gradient Instrument on the maps page. This uses GPS, groundspeed, and vertical speed information to display the climb gradient in feet per nautical mile, allowing the pilot to monitor the climb performance in real time.

Expanded SiriusXM Weather Layers

Pilots flying with the new Sirius XM SXAR1 aviation receiver have two new map overlay layers to display on the map in flight: Echo Tops and Cloud Tops. The cloud tops layer includes a slider at the bottom right of the map screen that allows the pilot to filter out clouds at lower altitudes. Tops above 25,000 ft. MSL are color-coded using blue, orange and red to visually enhance the highest tops. Tops below 25,000 ft., are shown as simple shades of gray.

The echo tops layer shows a graphical view of the highest altitude where ground-based radar detects precipitation returns above the 18dBz intensity threshold. The 18dBZ is normally shown as dark blue on a normal radar return. This represents the core of the precipitation in a storm or weather system and can be used to help determine the intensity of the system.

Arrival Alerts

To reduce head-down time in the cockpit while preparing for arrival, ForeFlight will display the weather frequency (ATIS, ASOS or AWOS) for the destination airport when 20 miles out in a pop-up message on the screen. The alert includes spoken audio of the weather frequency and it will remain on the screen until the pilot taps it.

Logbook Enhancements

ForeFlight continues to enhance the flight logging process, including:

- Recent airplanes: when you go to add a specific aircraft to a log entry, ForeFlight will automatically show the most recently used aircraft N#s at the top of the list.
- Instrument approaches: the logbook autofills the destination airport and shows a list of approaches for quick entry.
- Add currency tracking for multiple aircraft types: The currency summary will now track day and night currency by aircraft type, which is useful for those who need to maintain a certain level of currency in a specific type of aircraft. Tap "add currency summary" from the main logbook screen, select the new option "aircraft type currency" and choose the aircraft types you'd like to track. T&T

Former AgustaWestland Executive to Lead XTI Aircraft Company

XTI Aircraft Company (XTI), which is developing the TriFan 600 six-seat tilt-rotor business aircraft, has hired Robert J. LaBelle as its chief executive officer. He joins XTI after three years as CEO of AgustaWestland North America. Before that, he served as president of AgustaWestland Tiltrotor Company, Inc., the company supporting the development of the AW 609 Tiltrotor.

"I view this position with XTI as a unique opportunity," LaBelle said, "to help bring to the commercial market and business jet market a revolutionary new aircraft that people have been seeking and dreaming about for over 100 years."

LaBelle joined AgustaWestland in 2004 after a career in the U.S. Navy where he was program manager for several aircraft, including the E-2 Hawkeye, C-2 Greyhound aircraft, F/A-18 Foreign Military Sales, and S-3B Viking aircraft.

LaBelle replaces Charlie Johnson, who was XTI's interim CEO. Johnson will remain on XTI's board of directors, a position he's held since 2014.

"We're grateful to Charlie," said David Brody, XTI's founder and Chairman, "for taking over in February 2016 and leading the company after the tragic loss of Jeff Pino. We're looking forward to Charlie's continuing contributions and guidance as a board member."

The TriFan 600 will have the speed, range and comfort of a business jet and the ability to take off and land vertically, like a helicopter. Using three ducted fans, the TriFan 600 lifts off vertically. Its two wing fans rotate forward for a seamless transition to cruise speed, at 35,000 feet and 400 miles an hour, with a range of up to 1,600 miles. T&T

Apollo Astronaut at EAA AirVenture 2017 to Celebrate 50th Anniversary of Program

Astronauts from the Apollo missions that put humans on the moon for the first time are expected to be at EAA AirVenture Oshkosh 2017, as the airshow commemorates the 50th anniversary of the Apollo program. The 65th annual Experimental Aircraft Association fly-in convention is July 24-30 at Wittman Regional Airport in Oshkosh, Wisconsin.

The reunion is expected to be the largest gathering of Apollo astronauts at Oshkosh since the memorable 1994 "Salute to Apollo" program that brought together 15 of the men who were the faces of the American effort to put men on the moon. Many of the activities will be centered on AirVenture's Apollo Day Friday, July 28, which is highlighted by a major evening program at Theater in the Woods.

"A number of Apollo astronauts have already committed to the event, as have other people closely involved with America's space program during that era," said Rick Larsen, EAA's vice president of communities and member benefits who coordinates AirVenture features and attractions. "This will be a rare, unforgettable gathering of the people who met the challenge of flying to the moon and safely returning, representing hundreds of thousands of individuals who contributed to its success. You may never get another opportunity to see the people in person, up close, as you will at Oshkosh this summer."

It is expected that crew members representing many of the Apollo missions will attend. Those who have already confirmed their attendance include:

Frank Borman (Apollo 8)

Walt Cunningham (Apollo 7)

Fred Haise (Apollo 13)

Jim Lovell (Apollo 8 and Apollo 13)

Al Worden (Apollo 15)

Additional astronauts are expected to confirm their attendance in the coming weeks. Further details on events and schedules will be announced as they are finalized. T&T

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En Route

Lightspeed Aviation Unveils New Zulu 3 Headset

Lightspeed Aviation has unveiled the Zulu 3 ANR headset that adds several enhancements including:

- New contoured ear seals that are designed to hug the curve of the jaw, for a more natural fit that increases comfort and stability;
- New cables built around a Kevlar core that are stronger and more flexible than standard cables, while weighing less. These are the same cables that are standard on Lightspeed's PFX and Tango;
- Seven-year warranty;
- An optional, free taller head pad for smaller head shapes.

The Lightspeed Zulu 3 retains the familiar sleek, high-tech look of its predecessors and includes Bluetooth phone and music, the durability and longevity of nearly 100 percent stainless steel and magnesium construction, and user-adjustable mic gain and ear seals.

Zulu 3 is available with Dual GA, LEMO (panel powered), and U-174 (Heli) connectors and sells for $850. To learn more about the new Zulu 3 and Lightspeed's complete line of headsets and complementary pilot supplies, visit LightspeedAviation.com. T&T

En Route

Performance Aircraft Expands Into Jet Sales

Aircraft sales company Performance Aircraft announced today that Curt Epp, former regional sales director at Textron Aviation, has joined the company to specialize in managing jet and turboprop aircraft transactions. President and founder Bill Heckathorn said Epp will help the company launch newly expanded brokerage and acquisition services focused on helping more individuals enjoy high performance aircraft ownership.

"Having completed hundreds of aircraft sales transactions over the past 12 years, we are thrilled to begin working more actively in the jet and turboprop markets," Heckathorn said. "Mr. Epp's extensive aircraft knowledge and his dedication to customers make him the perfect fit for this new role."

Prior to joining Performance Aircraft, Epp worked at Cessna Aircraft Company/Textron Aviation for 16 years. As regional sales director at Textron Aviation, Epp was responsible for new turboprop sales. An accomplished pilot, Epp spent 14 years in the Flight Department as a senior training pilot. With type ratings in every Citation built, Epp has circled the globe in various jets and turboprops. T&T

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by **David Miller**

Which Airplane For Me?

Now that I have determined I simply cannot live without owning my own airplane, which one is the right choice? I narrowed my selection immediately by deciding that I must have two turbine engines. Nothing against the TBM, Pilatus and Meridian, or you fine piston folks. I just love the hum and theoretical safety of two kerosene-burning, turbofan propulsion systems and the dual everything that comes with them. Another wish list item for me is an integrated avionics system. Flying the Garmin G1000, G3000 and the Collins Pro Line 21 platforms has spoiled me. Call me lazy if you like, but I am blown away with the capabilities of these systems, particularly their vertical navigation (VNAV) abilities.

With that bias in mind, I set out to see what kind of turboprop I could find under 1 million dollars.

My first thought...the Twin Commander.

I have always been intrigued with the Twin Commander. It's built like a tank, very fast (up to 300 knots) and has a reputation as a "pilot's airplane." It has reliable, but noisy, Garrett engines. I looked online for available models, and subscribed to "Twin Commander," the leading newsletter. I visited a training facility with a motion simulator and spent an hour with an instructor. They referred me to a local guru, Barry Lane. I called him. "Barry, could you tell me a little about the Commander 840," I said. "I can do better than that, he replied. Let's go fly one."

Barry took me under his wing and spent most of the day with me including a demo flight. As we taxied out to Addison's (KADS) Runway 33, it was obvious that Barry was a master at his craft. We headed north as he extolled the virtues of the venerable Commander. He shut down an engine to demonstrate how docile the 840 could be. I was impressed. Best of all, the only thing I had to pay for was lunch. That was awesome. Pilots are a special group. Ask us anything about our airplanes, and we will invite total strangers to share our passion. That's pretty cool.

I traveled to Phoenix to look at an airplane that fit my price point. Tucked in the back of the hangar, it hadn't been flown in a while. Built in the early 1980s, it had more than 5,000 hours on the Hobbs meter. Reading its maintenance history was a little like traveling back in time. It had lots of dials, levers and switches. Lots of them.

During a walkaround, I saw some dents and dings, each with its own story. "That's normal for Commanders, the broker said. These airplanes are tough old birds. Aerial firefighters love them."The cockpit was a conglomeration of the old and the new. The Garmin G600 and 750 brought navigation and communications up to date. But there were little things that increased the overall workload. For instance, the de-ice boots must be manually cycled for each use. No automatic setting. More workload. Most importantly to me, there was no VNAV integration available from the FMS to the autopilot. Flying the Commander is like playing the piano. You must use your hands and feet at the same time.

I can't play the piano.

In the end, I decided that Commanders are too much of a challenge for me.

I decided to look at the King Air.

Stay tuned and fly safe.

With 6,000-plus hours in his logbook, David Miller has been flying for business and pleasure for more than 40 years. Having owned and flown a variety of aircraft types, from turboprops to midsize jets, Patty and David currently fly a Citation M2. You can contact David at davidmiller1@sbcglobal.net.

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