FLYING LESSONS for July 23, 2020

FLYING LESSONS uses recent mishap reports to consider what *might* have contributed to accidents, so you can make better decisions if you face similar circumstances. In almost all cases design characteristics of a specific airplane have little direct bearing on the possible causes of aircraft accidents—but knowing how your airplane's systems respond can make the difference as a scenario unfolds. So apply these *FLYING LESSONS* to the specific airplane you fly. Verify all technical information before applying it to your aircraft or operation, with manufacturers' data and recommendations taking precedence. **You are pilot in command, and are ultimately responsible for the decisions you make.**

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This week's LESSONS:

The U.S. National Transportation Board held public hearings and last week published its findings into the crash of Atlas Air Flight 3591, a Boeing 767 freighter that plunged nearly vertically out of an overcast into Trinity Bay in the final moments of its descent into Houston, Texas. The First Officer was the Pilot Flying at the time, and much was made of the First Officer's employment and checkride history and how that record may have been manifested in the accident sequence.

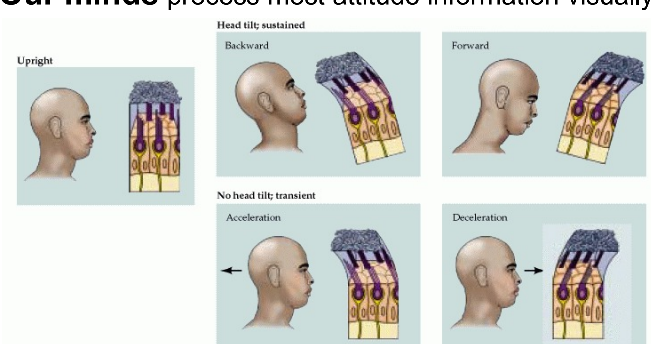
The proximate cause, however, appears to have been the FO's disorientation that resulted from acceleration, which itself automatically occurred after an inadvertent (and apparently undetected) activation of the autopilot Go-Around mode. The specific physiological process that causes such disorientation is called ***somatogravic illusion***—sometimes called "false climb" illusion. The *Aeronautical Information Manual* (AIM) notes:

> **Somatogravic illusion.** A rapid acceleration during takeoff can create the illusion of being in a nose up attitude. The disoriented pilot will push the aircraft into a nose low, or dive attitude. A rapid deceleration by a quick reduction of the throttles can have the opposite effect, with the disoriented pilot pulling the aircraft into a nose up, or stall attitude.

The Atlas Air crash reminds us that the somatogravic illusion exists. But what can those of us not flying transport category aircraft learn and apply to our flying?

See:
https://www.ntsb.gov/news/events/Documents/2020-DCA19MA086-BMG-abstract.pdf
https://www.faa.gov/air_traffic/publications/atpubs/aim_html/chap8_section_1.html

Our minds process most attitude information visually— millions of years of development has made a brilliant eye/mind connection. Take vision away (or severely restrict it with darkness or IMC) and our mind looks for other cues. Enter the inner ear. Sensing organs in our inner ear translate linear acceleration into attitude information for our brain to process. In a two-dimensional environment, that is, standing or sitting under positive G forces, movement within the inner ear helps us maintain balance and detect motion.



See https://www.ncbi.nlm.nih.gov/books/NBK10792/figure/A965/?report=objectonly

If your head tilts back the fluid in your inner ear moves toward the rear, moving sensing hairs. You get the sensation of pitching upward. If you accelerate the same thing happens, but you subconsciously use vision to overrule the sensation of pitching upward.

When your vision is impaired, for example, at night or in instrument meteorological conditions (IMC), acceleration is interpreted as pitching upward by our earth-trained brain. If you don't have a complement of flight instruments—or you are not using or do not know how to use them—you may mistake acceleration for pitching upward. Consequently, without a visual crosscheck these normal actions can give you a ***false climb illusion***:

- Low visibility takeoff and initial climb
- Level-off from a rapid climb

Failing to detect and compensate for false climb illusion prompts the unwary pilot to push the controls forward in an attempt to "correct." Symptoms: the airplane impacts the ground in a flat attitude at high speed, often close enough in to come to rest on the runway but also commonly resulting in impact with trees, wires or buildings far past the point where the airplane should have been above the obstacle's height.

They don't all dive in from altitude like Atlas 3591. Much more common is a failure to climb during takeoff in the dark, or controlled flight into terrain during departure into low IMC.

This scenario is usually described in the context of ***false climb***. However, just as acceleration causes inner ear fluid motion that moves the sensing hairs reward, so too may deceleration move the fluid forward, bending the sensing hairs with them in a direction we interpret as pitching downward. This ***false descent*** is rarely described, but it can prompt the vision-restricted pilot to believe he or she is pitching downward, and pull back on the controls when it is not warranted.

These normal activities can introduce a false descent illusion:

- Go-around, if the airspeed is allowed to decrease
- Missed approach, also if the airspeed drops
- Maximum performance takeoff, if the pitch attitude obstructs the horizon ahead of the aircraft

What's your defense from false climb and false descent illusions? Know not only the airspeeds to fly for each phase of flight, but also the pitch attitudes that are appropriate to attain and maintain those speeds.

In low light or IMC, any time your airspeed will change, or your attitude will change, or both, maintain your instrument scan to stay on attitude and airspeed despite the illusions.

Even in visual conditions, crosscheck your flight instruments—we used to call this an "integrated scan," combining glances at the gauges (or now, flight displays) with what you see out the windows.

It's common for pilots to have an almost obsessive interest in air crashes and air crash investigation. But as I try to point out in *FLYING LESSONS* each week, the challenge is to go beyond obsessive voyeurism and divine the *LESSONS* that apply to the aircraft and operations we fly, even if they are very different from those involved in the accident you study.

Comments? Questions? Send them to mastery.flight.training@cox.net

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Debrief: Readers write about recent *FLYING LESSONS:*

Reader Michael Gross wrote on Facebook about the Debrief in July 9th's *LESSONS*:

> The discussion of turning aerodynamics grates on me. It is clearly talking about *level* turns, as the discussion usually does. But **turns are not necessarily level**. One can trim for level flight, place the aircraft in a medium bank, and "let go." The airplane will keep turning, with the nose lagging somewhat due to adverse yaw, and will descend. This is a demonstration I like to give to kids, as it demonstrates that ***the airplane will just keep doing what it's trimmed for***.
>
> I think your correspondent assumed his airplane's apparently rather large adverse yaw effect was universal. A 172 will NOT stop turning if you let go of the elevator. The turn rate will slow down a bit and the nose will lag the turn.
>
> Now, if you try to do a steep turn, everything gets amplified. You won't be turning much if you let go at 60 degree bank, but it's still not gone. **What would be more significant is the spiral dive instability**. You're going to get fast in a hurry when that nose drops.

Thank you, Michael. As I wrote in the earlier *LESSONS* that prompted this discussion, "it's all interconnected." Practical aeronautics is a complex undertaking—and the outcomes change from one type of aircraft to another, in part why lack of total or recent "time in type" is a major factor in accidents.

See https://www.mastery-flight-training.com/20200709-flying-lessons.pdf

Reader (and Spitfire Association president) Geoff Zuber writes about high density altitude operations, the subject of last week's *LESSONS*:

> As you know from your trips here, Australian conditions regularly cause this condition and winter doesn't eliminate it. Whenever I fly in our A36 [Bonanza] and takeoff is likely to be hot and high (Arkaroola, William Creek, Mt Hotham and even the RWY 12 departure in Canberra where hills at the end of the runway can be challenging), the performance charts are part of the detailed planning. Lifting off late, slow initial climb and continued poor climb performance due to high density altitude make for consulting the POH and excellent Bonanza Performance App mandatory.

The proliferation of computer- and app-based flight planning programs make it hard to justify *not* checking performance data before flight. Thank you, Geoff.

See:
https://www.spitfireassociation.com
https://www.mastery-flight-training.com/20200716-flying-lessons.pdf
https://apps.apple.com/us/app/bonanza-performance/id910038344

Reader Marty Hill wraps it up this week with another comment about last week's density altitude *LESSONS*:

> I have lost her name but the lady CFI in Leadville, Colorado (she trained primary students in a Cessna 172) would remind transient pilots to leave their gear down until they had a good positive rate of climb. Seemed like good advice.

I expect one of our readers may be able to provide that instructor's name, but her advice is sound. Pilots of retractable gear airplanes should confirm a positive rate of climb is established before retracting the landing gear regardless of field elevation or density altitude. At high density altitudes it's even more important, in case a downdraft turns an already reduced climb rate into a descent back toward the runway. In fact, even in fixed gear airplanes pilots need to be cautious and deliberate as they establish initial climb at high density altitudes. Thanks for the reminders, Marty.

Questions? Comments? You know the drill: mastery.flight.training@cox.net.

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