FLYING LESSONS for May 31, 2018

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:

Video of a vintage P-51 Mustang that suffered intermittent power loss has circulated widely on the internet. This clip includes the video of the event and an in-depth discussion. It's worth the 35-minute viewing.

See https://m.youtube.com/watch?feature=youtu.be&v=BBpqvPujZgM

I'll draw your attention to two aspects of this incident:

1) Several times in recent weeks *FLYING LESSONS* has focused on the unique challenge of dealing with a partial engine failure in flight. The Mustang pilot had an intermittent, surging engine—likely a fuel availability (starvation, exhaustion), fuel delivery (carburetor, fuel pump) or ignition (magneto) problem.

See http://www.mastery-flight-training.com/20130502flying_lessons.pdf

2) We have also discussed in depth the controversial "impossible turn" scenario, when and how to make a return to the departure runway following loss of engine power. In my comments about a recent webinar on the topic I noted that, while we usually think in terms of absolutes—return to the runway or land straight ahead—there may be other options, with a turn less than all the way around. The P-51 pilot demonstrated this. He was aiming for the runway, but when it became obvious he was too low to make it he had the discipline to stop trying. He chose to touch down **W**ings level, **U**nder control, at the **S**lowest **S**afe speed. It worked out well for him—when had he tried to continue toward the runway the airplane almost certainly would have cartwheeled fatally. Well done, pilot!

See https://www.mastery-flight-training.com/20180322-flying-lessons.pdf

There are many good *LESSONS* from this video and analysis. One of the best is to resist the temptation to try to make it back to the runway under any circumstance, that if you get below about 400 feet in and engine-out glide that you need to abandon the runway and land straight ahead.

Comments? Questions? Let us learn from you, at mastery.flight.training@cox.net

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You consistently do an outstanding job in your *FLYING LESSONS* articles. You have the very uncommon ability to take what are really very complex subjects and present them in such a way that they are easily understandable. If I hadn't in the past studied some of the topics you present I would have no idea as to how complex they really are. Your explanations are clear and concise. You're providing a great service to any pilot that takes the time to read what you write.

– Reader, flight instructor and highly decorated Army Aviator Mike Friel

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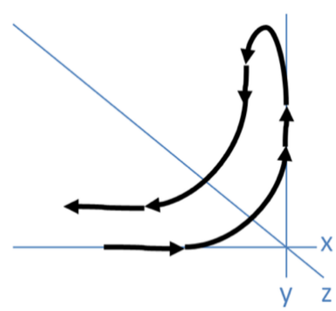
Debrief: Readers write about recent *FLYING LESSONS:*

Reader Art Bridge reflects on last week's *LESSONS* on spirals, and understanding of an airplane's reaction to inherent stability in general:

> A memory, Tom. I'm not recommending this for GA [general aviation], but this was how we did it in the military. The Whifferdill maneuver, has my memory holds it:
>
> Go full power, a slight descent, wings level, straight ahead. Get as much airspeed as possible, sometimes five or six hundred knots. Go into a fairly steep climb. Stay at full power. As airspeed drained off, a wingover one way or the other, releasing back pressure and remaining G forces.
>
> For sure, as indicated airspeed decreased, so did back pressure and angle of attack, almost none at times with zero Gs. Meanwhile our ground speed could still be hundreds of miles per hour.
>
> At 90° of bank, we had no G forces except gravity. At the lowest airspeed, we let the nose drop below the horizon in a peaceful, calm movement. At flying airspeed, level the wings with a little aileron and rudder. All the while stay[ing] at full power. Remember torque effect with opposite rudder. The airplane accelerates. You've gained a lot of altitude in a hurry.
>
> It was all very safe and graceful flying, probably the least demanding of aerobatic flight. But not for me now in my Bonanza.



You're right, Art—that is a graceful maneuver, albeit one requiring an aerobatics-certified airplane. In the right aircraft this would be a good *LESSON* in the applied relationship between aircraft stability, load factor and control.

See http://www.mastery-flight-training.com/20180510-flying-lessons.pdf

Reader Paul Sergeant adds:

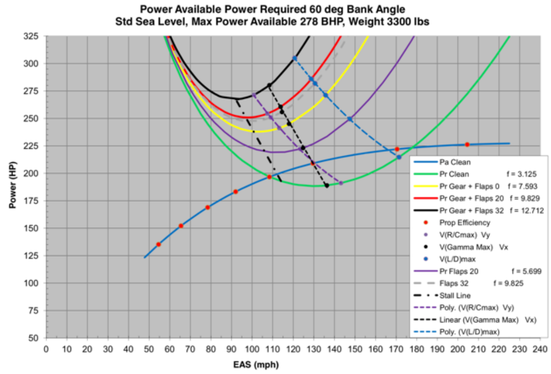
> All pilots with time in gliders are required to know about spiral dives. Part of the training for the private test is to deliberately let the airplane get slow, let the nose come down, and **diagnose if the glider is in a spin or a spiral dive**. Then the pilot must apply the correct procedure - rudder against the spin if the glider is in a stall/spin scenario, level the wings and pull up if in a spiral dive without exceeding "g" limits. ***The primary***

> ***means to tell them apart is the airspeed indicator***, which will either be showing **slow (spin)** or **increasing speed (spiral)**. As you noted, the sound of airflow also helps in the diagnosis, especially since it's not drowned out by an engine, as do the building "G" forces (in a spiral).
>
> I started out in gliders by necessity (little spare cash as a college student) but went back to it later out of love. I'm glad I did - I think it made me a better stick-and-rudder pilot, even in a high performance complex aircraft. I highly recommend gliding for everyone.

That's a good Task to evaluate—demonstrating the ability not only to recognize an unusual attitude, but also to properly diagnose its cause and apply the correct recovery technique. My first six hours were in sailplanes in the Civil Air Patrol in Hawaii, but looking back they were more rides than instruction. I need to get some real sailplane instruction some time. Thanks, Paul.

Reader David Rogers, aerodynamics professor emeritus at the U.S. Naval Academy, explains this more deeply:

> This accident [the SNJ crash that was the basis for last week's *LESSONS*) intrigued me for a number of reasons. Let me use this for a simple discussion of aircraft dynamic stability followed by an alternate explanation of why the accident happened.
>
> First, let's talk about what the FAA calls "an over banking tendency" and aeronautical engineers call the spiral mode. What we are talking about here is dynamic stability as contrasted to static stability which is associated with weight and balance. And aircraft can be statically stable and still be dynamically unstable.
>
> Static stability is only concerned with the initial tendency for the aircraft (system) to return toward the initial aircraft state (condition). It is NOT concerned with the subsequent nor the ultimate motion, or state, of the aircraft. In fact, an aircraft can be statically stable and dynamically unstable. However, it cannot be statically unstable and dynamically stable.
>
> Dynamic stability is concerned with the resulting motion of the aircraft. Dynamic stability is typically divided into longitudinal (angle of attack/pitch) stability and lateral (yaw/roll) dynamic stability. Lateral stability is typically a result of the "coupling" of the yaw and roll motion of the aircraft.
>
> Typically, there are two longitudinal dynamic stability modes: the phugoid and the short period. The phugoid is typically oscillatory and has a long period, i.e., on the order of several tens of seconds. It is also damped, i.e., the amplitude of the oscillations decrease[s] with time and hence it is stable. A pilot typically uses the phugoid mode to change altitude, although s/he does not know that is what s/he is doing.
>
> The short period can be either oscillatory or dead beat, i.e., non-oscillatory. If oscillatory, the period is typically on the order of low single digits or less. It is so quick that a pilot does not typically notice it. However, it is critical from a flying qualities viewpoint because it controls the aircraft response to disturbances/turbulence. One does not want an unstable short period.
>
> Typically, there are three lateral dynamic stability modes: the spiral mode, the rolling convergence mode and the dutch roll. The spiral mode - what the FAA calls the "over banking tendency" - can be either stable or unstable. Typically, it is marginally unstable. [In] the Bonanza [I fly] spiral mode is marginally unstable. It is a roll-yaw coupled motion that typically, in our aircraft, depends on two yaw stability derivatives and two rolling stability derivatives. The rolling convergence mode is typically mildly stable. It typically depends mostly on a single stability derivative and the inertia of the aircraft about the roll axis. Hence, it is more stable with tip tanks, especially when full, than without. The dutch roll is typically mildly stable. The dutch roll depends on multiple yaw and roll stability derivatives and the inertia of the aircraft about the roll axis and the yaw axis. Again, tip tanks "stiffen" the motion.



With that said, let's turn to the SNJ-5 accident. I don't think that the root cause is a result of a spiral, "over banking tendency". I think it a result of a failed attempt to operate the aircraft near the lower intersection of the power available and the power required curve shown in the [graph from his online paper]. In that [graph] the blue line is the thrust horsepower available and the green line is the thrust horsepower required to maintain a level 60 deg banked turn. The red dots indicate the percent propeller efficiency. The left red dot is 50% increasing to the right 5% for each dot until the last two dots are approximately 81%. The left chain-dotted black line represents stall. Notice that the horizontal axis is equivalent airspeed - EAS. That [graph] is for an E33A Bonanza and not an SNJ-5. The SNJ-5 is heavier, with a longer wing span, more power and certainly more parasite drag. In my view, those characteristics combine to yield a graph similar to that illustrated but with different numbers.

Based on the description in the NTSB report this maneuver occurred just after takeoff and hence at low speed, i.e., the aircraft was operating near the lower intersection of the blue thrust power available curve and the green thrust power required curve where available rate of climb in a 60 deg bank was minimal and near the stall boundary. If the pilot increased the bank angle to more closely align the aircraft to pass over the airport, then the aircraft would be operating where the available rate of climb was negative and if he then loaded the aircraft with aft stick in an attempt to decrease the rate of sink the aircraft probably stalled at that point. At that point even decreasing the bank angle in an attempted stall recovery would not have helped.

I call these types of accidents iLOC for "ignorant loss of control." Pilots simply do not understand the negative performance penalties of adding parasite drag, e.g., extending gear and flaps as shown in the image, nor do they understand the negative performance penalties of high bank angles. Mostly, that is because these topics are not adequately addressed in training. In addition, the unstable spiral dynamic stability mode is quite slow to develop. So, there would not have been time for the spiral instability to significantly affect the aircraft. For example, it took 20 to 30+ seconds to go from a 20 deg bank to a 60 deg bank when demonstrating the spiral mode using an A36 with tip tanks in the flight test course.

See http://www.nar-associates.com/technical-flying/2-chart/Two-ChartPerformance_wide-Rev6_notes&N&J_screen.pdf

Thanks, Dave. The depth of your knowledge is always impressive. My experience (from regularly demonstrating the spiral tendency of Beech Bonanzas) is that, if the airplane is put into a level 35° to 40° bank and the controls simply released, that the bank angle increases to near 60° in less than 20 seconds (if permitted to do so). More importantly in this context, the rate of descent goes from zero to as much as 1000 feet per minute or so in the same interval. You are undoubtedly correct in the technical nuances of this theory of what may have happened in this case. We agree that the human response to the result of the stability-driven bank and pitch changes close to the ground is likely what quickly turned this attempted departure into tragedy. The NTSB investigators will hopefully determine whether the airplane was in a stalled condition at impact, and whether any engine, medical or other factors played a part. The larger *LESSON*, regardless of the cause of this specific crash, is a better understanding of the aerodynamic tendencies of our aircraft.

Questions? Comments? Suggestions? Let us know, at mastery.flight.training@cox.net

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