FLYING LESSONS for August 13, 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:

Relationships

Have you ever noticed some of the relationships that apply to aircraft performance?

Most pilots somewhat grudgingly learn to use the Performance charts in the handbook for the airplane they fly. Some of us may really get into making these calculations, but we would have wanted to be a navigator on a Pan Am flying boat or a flight engineer on a Capital Airlines Lockheed Constellation too. As an instructor I know, however, that the use of performance charts is often hard to grasp, and many (dare I say most) pilots learn enough to get through the writtens and Practical Tests, then stop paying much attention to the charts at all.

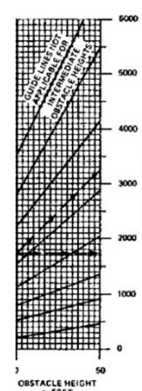
Today's flight planning software helps immeasurably, but even so many pilots don't "get into" flight planning. Instead they rely on approximations and rules of thumb…usually these work, but sometimes they don't tell the whole picture.

I encourage you to make a few calculations for each airplane type you fly. ***First*** to **refresh** yourself on how to read the charts, but ***second***—and this week, more importantly—to identify some of **the relationships** between different performance figures, to help you more completely manage the risks and take advantage of the opportunities presented by the aircraft.

For example:

Takeoff ground roll distance vs. 50-foot obstacle distance

Make three or four takeoff distance calculations for an airplane you fly, at various temperatures and airplane weights at fairly low field elevations (a couple as sea level, a couple at 2000 feet, etc.). For most types, the Takeoff Performance chart gives two results: a ground roll distance (assumes zero obstacle) and a distance to clear a 50-foot tall obstacle. Compare the two results.



You'll probably find a rough rule of thumb for that particular airplane. For example, in the airplane I most commonly fly, a general rule is that the distance to reach a point 50 feet above ground level (assuming a maximum performance, V_X departure) is approximately twice the ground roll distance. Put another way, if the airplane takes 1000 feet over pavement from power-up to wheels off the ground, it will take another 1000 feet—2000 feet from the power-up point—to clear an FAA-standard 50-foot tree or power line.

You can even see these relationships without making a calculation, if your handbook's charts follow the near-stand format like that pictured. Pick a point at the 0 Obstacle point (the left edge of the box illustrated) and note the corresponding ground roll distances on the right edge of the box. Then from that same starting point at the left, follow the slope of the nearest line upward until you get to the right edge.

The relationship may be different for your airplane, but at least now you know a bit more about the "big picture" if you are thinking about flying into a short runway with trees in the departure path. Considering flying into a 2300-foot grass runway with obstacles? Some pilots focus on the runway length alone. Knowing these relationships reminds you to check the obstacle clearance distance as well.

Takeoff distances at low vs. high density altitudes

Using the same technique, make a few comparative calculations for takeoff and obstacle clearance at the low altitudes you already checked, and then at a higher density altitude, say 6000 feet higher (sea level vs. 6000 foot, in the case above, or field elevation and 11,000 feet if you live in Denver, for example). This helps you better visualize a winter vs. summer day, or that summertime trip to the mountains for a lower-elevation pilot. With a few comparison calculations, develop an understanding of how much your airplane's performance changes with an increase in density altitude.

You may have already noticed on the performance chart excerpt above that the slope of the lines is steeper at higher altitudes. This tells you that the **relationship** between ground roll and obstacle clearance distances is different at higher density altitudes.

Best Glide and descent profile vs. short field final approach rate of descent

Because of the popularity of tablet-based flight charts and moving maps, and the fairly recent introduction of a "glide ring" option that depicts the "footprint" the airplane can reach on the ground in an engine failure at Best Glide speed in the glide configuration, many pilots are becoming more aware of their airplane's ***glide ratio***. The glide ratio is the **relationship** between the amount of forward distance the airplane can travel for some amount of altitude lost in the glide, usually 1000 feet.

Most light airplanes will have a glide ratio in the 8:1 to perhaps 12:1 range, with the actual amount varying widely between airplane designs. If this information is published for your airplane type you'll usually find it with the Glide checklist in the Emergency Procedures section, or perhaps in Limitations or Systems Description.

Two interesting relationships exist in many aircraft: **(1)** the Best Glide speed is very close to the speed recommend for final approach on the Landing Performance chart, at least for airplanes with light wing loading—the Landing Performance chart in most handbooks describes a short field technique; and **(2)** in most airplanes I've flown you can visualize the glide radius in flight by drawing an imaginary circle from wingtip to wingtip as seen from the pilot's seat. Anything on the ground within that circle is likely to be within your Best Glide range unless there is a strong wind.

Consult your handbook and practice in flight to find the **relationships** that apply to the aircraft you fly.

Cruise speed vs fuel burn (knots per gallon)

Next time you're taking a trip and you're not in a huge hurry, try out a few different cruise power settings within the allowable range of any aircraft Limitations. Repeat the exercises over time to compensate for the effect of winds on flight planning. The end goal is to look at the **relationship** between cruise speed and fuel burn, expressed in knots per gallon (liter for my international readers), as a way of selecting efficient cruise power settings using whatever definition of "efficient" you choose for a given flight.

In an aircraft with a fixed-pitch propeller, establish cruise at a chosen RPM and mixture leaning technique. Note the cruise speed and fuel burn—if you don't have a fuel flow gauge or fuel totalizer, you may have to do this on separate trips to determine relative fuel burn by noting how much fuel is needed to top off the tanks. Do your test runs at similar altitudes to remove variables from your observations.

In aircraft with controllable pitch propellers, make a series of runs at constant manifold pressure or throttle position and different propeller speeds, or constant propeller speeds and varying manifold pressure.

Regardless of propeller type, you can do the same exercise at constant power settings with varying mixture management, for example, rich of peak vs. lean of peak operation, or 25°F vs. 100°F rich of peak, 10°F vs. 50°F lean of peak, whatever combinations work for your airplane.

Cruise speed vs fuel burn (time and fuel to cover distance)

Take another look at the data you collected in the speed per fuel burn exercise above. Calculate the total time and total fuel burn to cover a set of distances, for example, 100 nautical miles, 250 nm, 500 nm and 1000 nm, at each of the selected power and mixture settings. Ignore for now the climb and descent phases. The idea is to look at the **relationship** between time and fuel to cover distances.

You may find that aggressive leaning doesn't save much fuel because of the time it takes on a longer trip, or that running the engine flat-out doesn't save much time but burns a lot more fuel on a shorter haul. You could even calculate the effect of tailwinds or headwinds on this "efficiency index", and when it makes sense to fly slower but nonstop when flying faster requires a fuel stop. Again, this gives you some data to make decisions on whatever "efficiency" means to you.

50 ft obstacle distance vs landing roll distance

Just as you did with the Takeoff Distance charts, do some comparative calculations with the Landing Distance charts to find the **relationships** between the ground roll distance (0 obstacle) and the 50-foot obstacle clearance distance. Remember that this chart usually describes a short-field landing technique and maximum braking, with a steep-angle, power-off approach at a minimum safe speed.

In my experience pilots want to be more familiar with the performance of their aircraft, but unless they fly in a maximum-performance environment they rarely "crack the books" to see what their airplane can do. Sometimes this take an unfortunate turn when a pilot then tries to operate near the limits of their airplane's envelope, then fails to outclimb obstacles after lifting off from a short airstrip, or runs out of fuel just short of their planned destination, or clears the power lines off the arrival end of the airport only to roll off the far end after touching down.

Nothing replaces the need to calculate performance. But knowing the performance **relationships** will make seeing "the big picture," and when you need to really get into the books and fly using maximum performance techniques, more obvious.

Wouldn't it make a great and informative Flight Review to spend your time together with a flight instructor (or instructors, with your students) determining some of the performance **relationships** that apply to the airplane ***you*** or ***they*** fly?

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

Debrief: Readers write about recent *FLYING LESSONS:*

Reader Byron Hamby, a Designated Pilot Examiner, writes about [last week's *LESSONS*](https://www.mastery-flight-training.com/20200806-flying-lessons.pdf) on pilot proficiency with autopilots:

> Great article. I have had the unfortunate experience of failing many IFR applicants during Practical Test when they could not fly the airplane without the autopilot. Most say the same thing: "My CFI said I could use my autopilot." I usually see a pilot struggle to maintain altitude and safely fly the airplane [in] single pilot IFR. And I must tell of one failure: The pilot sent me a letter thanking me for failing him. He reevaluated his training and became a much better pilot. Sadly, some pilots continue to have a dependence on technology.

There is a fine line between proficiency and overdependence on the use of technology. We don't want to deprive ourselves of the capability and safety possible with modern autopilots. But we must also be prepared to, just as safely, fly the procedure by hand in the event these autopilots—which rarely have redundancy in general aviation aircraft—are not capable of doing the job.

I believe instructors and examiners must prepare pilots to fly in all modes. In the case of many airplanes, even trainers today, that means demonstrating proficiency in hand-flying, use of a flight director, and flying fully coupled approaches. Each mode has its own techniques, risks and rewards. In transition training and Instrument Proficiency Checks I have the Pilot Receiving Instruction (PRI) practice and show competence in as many of these modes as is available in the airplane being flown. Is it overkill? No, we're just complacent because so many of our autopilot systems are new enough they haven't begun to routinely fail. I applaud your failed applicant for learning that *LESSON* as a result of flying with you. Thank you, Byron.

See https://www.mastery-flight-training.com/20200806-flying-lessons.pdf

Reader/instructor Dick Druschel adds:

> I am not sure that I agree totally with your advice to the aging pilot. Was it good advice? Sure it was. But I think it was incomplete.
>
> That wing-leveler was old to begin with and is not getting any younger. It is not a matter of *if* it will fail, it is a matter of *when*. The pilot was telling you that he uses the autopilot frequently and realizes that he feels the need for a better and more modern autopilot. It would reduce his workload dramatically and make the flight safer. I would have suggested that he replace the autopilot, if he could afford to, **AND** get some extensive training on using it. Older airplanes, like older pilots, need some upgrades periodically to keep them functioning properly and safely.
>
> **New equipment can help us manage our flights better and more efficiently but only if we understand them totally**. So, no matter what advice is given and no matter what course of action is taken, **training is an absolute must**.

My thinking (that I related last week) was based on the pilot's statement that he is currently happy with his autopilot and how he uses it. His concern, fear really, is that as he continues to age he may lose his ability to do what he's currently doing. Cost of a new autopilot was a major issue for him, especially given the relative cost of an autopilot vs. the value of his airplane now and after such an autopilot was added.

I did review the new autopilot options available to him, and as I began my response, that a new-technology autopilot would be far less likely to fail than his tried-and-true, but decades-old equipment. All that said I agree with you—regardless of the option he chose, I stressed then and now, he needs to make **a commitment to training**. Since cost was an issue for him I suggested he continue to use his still-supported autopilot, but that he firmly schedule regular training to make sure he is still safe doing so…as well as being able to hand-fly in the event the autopilot failed. If he finds he is not capable of both, I suggested, he should then make a different decision based on whether he has the skills to make use of a new autopilot's abilities (as opposed to simply being along for the ride when he uses it).

Should I have pushed him further toward a new autopilot? Not unless he planned to remain proficient with (and without) it as well. To repeat the FlightSafety International slogan, "the best safety device in an aircraft is a well-trained pilot." That's really what I was getting at: address the pilot issues first, and the technology next. Thanks, Dick.

Reader Christopher Skelt responds to last week's Debrief, where I answered a reader's question about learning the proper liftoff attitude in a Light Sport aircraft he flies:

> I read your advice for reader Les Ferguy on getting the right landing attitude for his Eurostar. If regulations permit it for his EV97, the best solution in my opinion is a GoPro or similar attached to the tail tie-down ring. Not only does this show you the position of the nose wheel when the mains touch down, but it also helps you to link your perceived height in the flare to reality, how close you are to the center line, and how well you're handling any crosswinds.
>
> If Les' worries about a tail strike are well founded, the life of the GoPro will be limited (!!). But aircraft are often perceived by the pilot to be more nose-high than they really are. Here's a nice example on YouTube.

Great idea, Chris. Thank you.

See https://www.youtube.com/watch?v=lUWrg9XE8_k&feature=youtu.be

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

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Runway Safety Boy

My friends at the National Association of Flight Instructors (NAFI) sent me this delightful item that reminds us that pilots are role models, and kids often know what's right to do. Enjoy!

See https://vimeo.com/446497303/3aa3deadf4

Share safer skies. Forward *FLYING LESSONS* to a friend

Pursue *Mastery of Flight.*

Thomas P. Turner, M.S. Aviation Safety
Flight Instructor Hall of Fame 2015 Inductee
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